For the Sake of Argument

Mental Attitudes . . . .

By Norman G. Shidle

Failure or success depends as much on mental attitude as on skill. Mediocre skills, backed by an it-can-be-done belief, will score more points in business or sport than technical perfection tainted with indifference, worry, or fear. . . . The ball carrier who gets started fast and runs hard makes more yardage in a season than the fastest runner. The alert behemoth will recover more fumbles than the nimble pigmy who woolgathers.

Hiring and promoting, we are too often satisfied with an experience record which proves familiarity with the work. Mental-attitude intangibles are harder to evaluate, more difficult to specify. Neither aptitude tests nor other mechanical devices picture accurately what we want to know. Only long experience trying to relate mental attitudes with the results produced by each specific individual seems importantly helpful . . . and it is the exceptional supervisor who has both time and facility for developing such undertanding of more than a few persons.

Mental attitudes can vary widely, too, in the same person. Personal troubles can cloud business vision or deplete creative effort. . . . Some executives are noted among subordinates for having their "good" and "bad" days for no reasons discernible to others than the man himself. . . . "The morning after the night before" is a not unfamiliar influence on mental attitudes. . . . Mental lethargy comes sometimes as a creeping ailment, growing so slowly it is hardly noticeable at any given instant. ("A large part of the world's troubles," Bruce Barton says, "arises from the fact that its affairs are being conducted by tired men." . . . But no individual has anything to worry about on this score until lack of zest becomes habitual—when the change becomes not one of mood but of man.)

Most of us subscribe in theory to the thesis that mental attitudes are important to business or professional results, but continue to be a bit surprised at the regularity with which the theory works out in practice.

SAE Journal

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TABLE OF CONTENTS

Society of Automotive Engineers, Inc.

James C. Zeder
President

John A. C. Warner
Secretary and Gen. Manager

B. B. Bachman
Treasurer

To All Members . . .

The past year has given me a better understanding of the wide scope of SAE activities and I have been impressed and pleased at the extent to which the Society appears to be meeting the diversified needs of its members. It has been equally gratifying to find so much life and activity in the Sections, for their well-being is vital to the strength of the Society.

Our SAE is not a slot machine into which a member deposits his dues in the expectation of receiving a package of benefits. You and I and a host of others make up the SAE and whatever is to be received from the Society, we must put into it. Hence it is heartening to note the vast amount of time and effort directed to SAE affairs by officers and committees. But since terms of office are limited and changes in committee personnel are frequent, the responsibility for keeping the mechanism of the Society functioning smoothly rests with the permanent staff. No one who has observed this group at close range can doubt that the responsibility is in good hands.

Reference has been made to the mechanism of the Society but the SAE is not a machine. It is an organization of people—talented people, friendly people, kindly people. During the year I have received full measure of this kindliness and friendliness and I am deeply grateful for the privilege that has been mine.

Stanwood W. Sparrow

President's Report for 1949

THE Society continued to expand in most areas through 1949, though at a lesser rate than in recent years. Improved services resulted, in combination with additions to surplus desired by the Finance Committee.

Technical committees served new areas of industry and completed scores of new projects in areas previously served. Attendance at National Meetings was greater than ever before. Publications carried a few more pages than in 1948, and incorporated a number of new editorial features. Membership held close to the all-time peak of last year, but failed to record a new high for the first time in 15 years. Student enrollment, however, growing by 33%, did go to a new high of 5021. Addition of new Sections and Groups brought the total of these units to 39. . . . The Society again added substantially to its reserves in accordance with Finance Committee aims—partly through increased income and partly by vigorous pursuit of ways to hold down expenditures.

Meetings Attendance Sets New High Mark

Stimulated by new meeting forms and program innovations, registration at the 10 SAE National Meetings held throughout the country in 1949 reached an all-time high of over 9800 members and guests. Four of these meetings set new attendance records.

A new meeting arrangement made its debut in November—the "dual" meeting, in which two separate meetings are held consecutively at the same hotel. By this plan two meetings can be attended at little more than the time and expense required to attend one.

Another successful "first" was the informal round-table discussions which replaced some of the previous technical sessions at the Summer Meeting. Use of all-day panel discussions and production clinics was extended to additional meetings, so that the benefits of these effective means of exchanging technical information could be brought to new sectors of SAE membership.

An Annual Meeting attended by more than 4000—the second largest in SAE history—started off the year. Next came the SAE National Passenger Car, Body, and Production Meeting held in Detroit. With its outstanding production clinic, the meeting was attended by over 1200 members and guests, thus taking its place as the second largest of the SAE's National Meetings.

Next came a spirited National Transportation Meeting in Cleveland, and a National Aeronautic and Air Transport Meeting in New York notable for the successful introduction of the all-day panel discussion—similar to the one initiated at the 1948 National Aeronautic Meeting in Los Angeles. This meeting also featured the debut of its first organized Aircraft Engineering Display, similar to the one which complements the National Aeronautic Meeting in Los Angeles.

The 1949 Summer Meeting stands out on three counts—an all-time attendance peak; debut of the singularly successful round-table discussions; and the spectacular "automotive circus" which replaced the previous field day.

In August the National West Coast Meeting was held in Portland, Ore. This was the second of these meetings to be sponsored by four SAE Professional Activities—Transportation and Maintenance, Truck

and Bus, Fuels and Lubricants, and Diesel Engine—and the eight West Coast Sections and Groups.

The National Tractor Meeting, held in Milwaukee in September, was the third meeting to break previous attendance records, with a registration close to 800.

The Los Angeles National Aeronautic Meeting held in October stood out for a program that bristled with top-level engineers from the military, government, and industry.

The SAE's first "dual" meetings completed the schedule. The National Diesel Engine Meeting, Nov. 1 and 2, and the National Fuels and Lubricants Meeting, Nov. 3 and 4, were held consecutively at the Chase Hotel, St. Louis, Mo. Partly as a result of this plan, both meetings drew large attendance. Almost 500 turned out for the first separate National Diesel Engine Meeting to hear a program emphasizing railroad applications of diesel engines; whereas the National Fuels and Lubricants Meeting set a new attendance peak with a registration of 635. Favorable reaction from the attendance at both meetings indicates the success of this experiment.

Membership Close To All-Time High

The SAE closed its 1948-1949 fiscal year, Sept. 30, with 14,673 paid up members on its rolls, a figure slightly under the all-time record of 14,911 reached as of the same date a year ago. The greater than normal membership loss was anticipated and reflects severances due to transfers from the automotive industry, financial reasons, retirement from active business, the new schedule of SAE dues, and difficulties encountered by overseas members in purchasing U. S. dollars.

The fact that applications for SAE membership, which totaled 1772 during the year, were slightly greater than for the previous year, coupled with probabilities that membership losses will be somewhat less during the next 12 months, indicates that the SAE membership curve is likely to swing upward again during the 1949-1950 fiscal year.

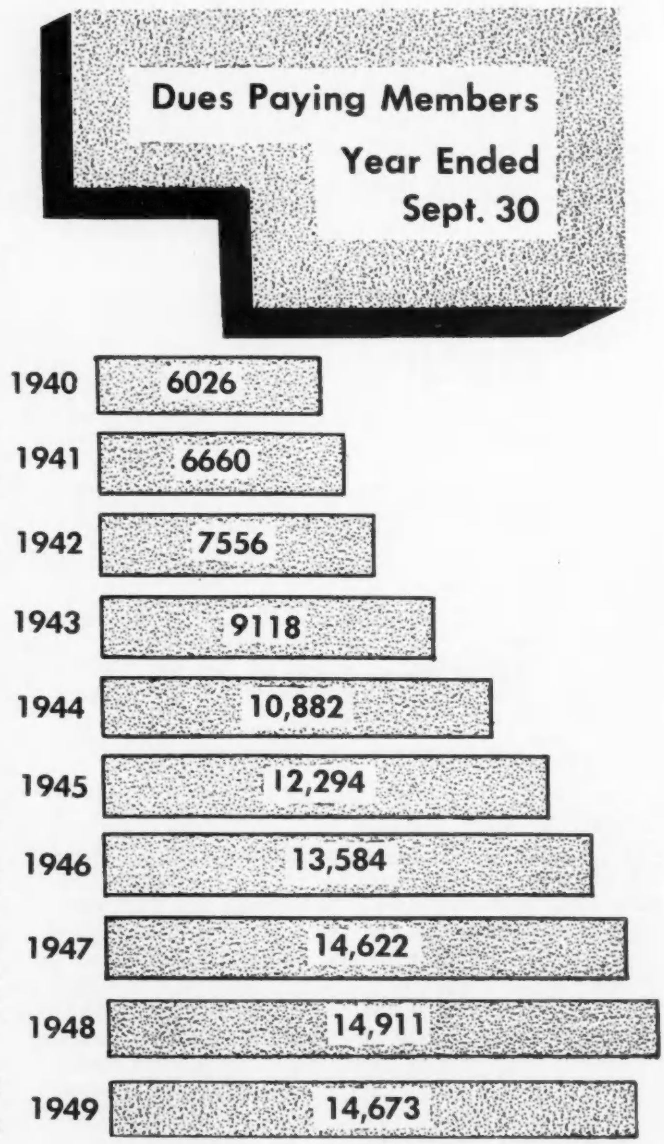
SAE membership committees, both Section and National, have been alert to bring qualified men into the Society and are cooperating to maintain the high standard of SAE membership.

33% More Students

Student enrollment has gone up about 33% this year. It totaled 5021 for the fiscal year ending Sept. 30, 1949, as against 3795 a year earlier.

Additionally gratifying is a substantial increase in the proportion of Enrolled Students making application for regular membership after graduation. More than 25% of those graduating last year applied for membership—effort to up that percentage further continues to be a major Student Committee aim.

Twenty-eight Student Branches and eight Student Clubs now are in operation throughout the country. Three new Student Branches were established during 1949—at University of Illinois,



California State Polytechnic College and Indiana Technical College.

Student interest in SAE continues to grow, due in no small part to fine efforts of our Section Student Chairmen and College Faculty Advisers. Upon their shoulders rests the real key to the success of the SAE Student program.

Technical Committees Into New Projects and New Areas

SAE technical committees operating under the Technical Board again report a long list of achievements of significant value to the automotive industries from which the Society draws its membership. This phase of the Societys' activities was started nearly 40 years ago at the request of the then infant automobile industry. It has expanded in size and scope, not only as automobile manufacture has developed, but also as the term "auto-

motive" has come to include all the great industries based on the high-speed internal combustion engine.

As the operations of SAE technical committees have grown to meet the expanding needs of the automotive industries, the value which these industries place on this work has kept pace. Currently, as revealed elsewhere in this report, these industries are underwriting direct SAE costs of this work which is carried on primarily for their benefit. Moreover, the manner in which general management supports SAE technical committees, by making available vital engineering manpower, is even more striking evidence of the industrial importance of the work.

Important accomplishments by SAE technical committees during the past year were many.

Among the 1949 fruits of the Iron and Steel Technical Committee's work are standard hardenability bands for 75 alloy steels, a new standard for materials for nuts, bolts and fasteners, and a new recommended practice for tool and die steels. In addition, this committee has nearly completed reports on measurement of depth of casehardening and on an extensive project on the low-temperature properties of ferrous materials. It also has under way projects on seam depth and decarburization, on a test method for determining hardenability of carbon steels, and on nodular iron. In addition, it is considering investigation of possibilities of standardization of steels for agricultural implements.

The Aeronautics Committee during the past year has revised and issued 87 Aeronautical Materials Specifications, 25 Aeronautical Standards and Recommended Practices, 129 Recommended Government Standards (AN) and 6 Information Reports.

In the aeronautical materials field, the SAE AMS Subdivision has continued its progressive program of developing new and revised aeronautical material and process specifications for all phases of the aeronautical industry, laying increased stress on development of specifications needed for turbine engines. In this area 22 specifications were developed for high temperature material applications.

The Aircraft Engine and Propeller Utility Parts standardization program has resulted in a series of standards which were submitted to the Aircraft Industries Association for release to the Government with the recommendation that they be published by the Government as AN standards. These standards, developed in the past year, will form nuclei for the new series of engine and propeller utility parts standards, and will aid materially in resolving problems of maintenance, service and supply for both the industry and the Military Services.

As in the past a number of standards and recommended practices were developed by the SAE at the request of the Aircraft Industries Association and the Air Transport Association of America. These standards form the basis of many of the technical standard orders issued by the Civil Aeronautics Administration for the purpose of defining performance requirements.

In the field of Aircraft Accessories and Equipment, operations were broadened at the request of the Aircraft Industries Association to include consideration of installation as well as equipment problems. Many such projects involve development of recommended revisions pertaining to present and proposed AN standards.

At the request of the Air Transport Association of America a new committee was recently organized to work on complex problems involving cockpit standardization for transport aircraft.

The Construction and Industrial Machinery Technical Committee, consisting of engineers from the manufacturers of earthmoving and off-the-road equipment, continues to make great progress. Doing a pioneering job, the many projects on its agenda have created a problem of priorities. Currently its active interests include drawbar and tractor equipment mounting, yardage rating of body and buckets, hydraulic power controls, electrical equipment, clutch engine and flywheel mountings, cutting edges, tractor and shovel dipper rating and brakeshoe widths and mountings.

The work on automotive drafting standards has gone forward rapidly during the year and it is now anticipated that the first publication of these standards will occur early in 1950. This has been a big job and it is believed that when these standards are published, they will represent one of the most important services ever rendered to industry by an SAE technical committee. These standards are being developed to meet the drafting needs of manufacturers of ground equipment, since the needs of the aeronautical industries already are taken care of by the Aeronautical Drafting Manual.

Revision of the widely used SAE Crankcase Oil Viscosity Numbers is under consideration by the Fuels and Lubricants Technical Committee, its object being to simplify the distribution of these oils. This committee is working also in cooperation with the Coordinating Research Council to develop field experience on a low viscosity, low temperature oil to facilitate starting in frigid climates, with the thought that such an oil might ultimately be included in the standards classification, with the designation 5W. This project also includes the possible consolidation of the 10W and 20W oils in the classification.

In the marine field, the SAE Standard for Taper Bore Couplings has been revised and extended to include a series of straight-bore couplings with flanges to match those of the taper-bore couplings. A new standard for straight-bore couplings with external pilots also has been developed. In addition, a completely new standard for shaft ends and propeller hubs for shaft diameters up to 8 in. has been created to supersede the old standard.

The Non-Metallic Materials Committee has revised the Standard for Vacuum Brake Hoses, and is working cooperatively with the Passenger Car Body Engineering Committee on standards for sound-deadening materials and fiberboard. The latter committee is making considerable progress towards establishing a common nomenclature for principal parts used in body construction. In addition it has developed standards for cylinder locks and keys and has recommendations in progress on the direction of rotation of keys, strength of keys, and so forth. Considerable progress also has been made on window glass runways and channels.

Among the projects of the Screw Threads Committee is a study of protective coating of threads and the allowances required for such coatings.

This committee is working in close cooperation with ASA Sectional Committee B1 on Screw Thread Gaging. It has developed a proposed standard for automotive hexagon head bolts. These new bolts are expected to be included in the American Standard now under review by ASA Sectional Committee B18.

The Truck and Bus Technical Committee has completed measurements of traffic noise at Eastern, Midwestern, and Pacific Coast locations. It also has developed a tentative specification for the kind of meter needed to measure such noise if this approach were made to the enforcement of legal prohibitions of excessive noise.

Early this year the Electrical Equipment Committee completed action on an extensive revision in the SAE Storage Battery Standard, and currently has under development standards for circuit breakers and radio suppressors, along with the revision of existing standards for cables and fuses.

The Engine Committee has an extensive program involving 10 active subcommittees on the development of dimensional standards for a variety of engine parts, including shell bearings, carburetors, fan mountings and thermostat pockets. This committee also has completed a revision of the Gasoline Engine Horsepower Test Code and is about to start a revision of the Test Code for Diesel Engines.

Sections Intensify Service to Members

Meeting their assignment to provide technical fare for the members in their localities, the Society's 39 Sections and Groups, in the 1948-1949 Section year, held approximately 335 meetings at which prominent engineers of the industry presented papers to an overall audience of more than 40,000. Augmenting these sessions, Section and Group members also participated in plant visitations, as well as in such social events as golf parties, ladies nights and the like.

Visits to many of SAE's local organizations reveal clearly the enthusiasm of the members and the untiring efforts of their Governing Boards to make them of outstanding value to the membership. Sections and Groups are particularly interested in the Society's Student program and are cooperating with SAE Enrolled Students in neighboring colleges and universities. They also are offering a cordial welcome to the young engineers entering the industry and providing these men with opportunities to participate in SAE Activities.

The SAE British Columbia Group was advanced by the Council to Section status early last year, and a new SAE Atlanta Group recently has been recognized by the Society.

Placement Service Has an Active Year

Continued recognition by employers of the caliber of SAE members, plus the facility in using the SAE Placement Service, has broadened the list of active company contacts to a total of 576. This is an increase of 155 over last year which is particularly gratifying in a period of general tightening up throughout industry.

Although member registration increased by about 40%, there was a still greater increase in the number of Enrolled Students' applications. This was mainly due to the promotion of the Placement Service among the students, as well as the comparative difficulty encountered by recent graduates in getting properly located. To simplify the use of the "Men Available" bulletin, a separate section is now devoted exclusively to the listing of current graduates.

SAE members are appreciative of the efforts of their Section Placement Chairmen in building up an effective consultation service for those in need of advice. A further broadening of this valuable phase is under way, as are continuing efforts to make the service increasingly helpful.

Publication Changes Aim At Better Member Service

During 1949, SAE Journal continued to publish promptly material from every paper presented before the Society; SAE Quarterly Transactions reduced the time between presentation of a paper and its publication in full (when approved); and the Special Publications Department distributed more than 100,000 copies of SAE papers and technical committee reports. New covers were developed for both SAE Journal and SAE Quarterly Transactions.

SAE Journal

SAE Journal kept printing promptly technical material from every paper presented before the Society. As last year, it enters the new year without a backlog.

Relieved of 1948's strike-born mechanical difficulties, every issue in 1949 was in the mails on its appointed publication date—the 5th of the month. Total editorial pages published in 1949 were 942 as against 923 in 1948.

Editorial activity during the year included: introduction of a "news short" feature titled "You'll Be Interested to Know . . . ," study and experimentation resulting in a new paper permitting better reproduction without increased cost; development of a new cover format which will remain the same from month to month (at considerably decreased cost); attempt to improve the effectiveness of personal and obituary notes; development of more technical feature material from SAE technical committee findings; and perfecting of policies and procedures bringing far more effective use of Coordinating Research Council material than ever before.

SAE Quarterly Transactions

The time between presentation at a meeting and publication of a paper in SAE Quarterly Transactions was cut materially in the last half of 1949, when it averaged 8 months. (In 1948, the average was 9.5 months, and in the first half of 1949, it was 10.3 months.) All papers approved by Readers Com-

INCOME AND EXPENSE

Oct. 1, 1948 to Sept. 30, 1949

In Agreement with Haskins & Sells Audit

Income

Membership		
Dues Earned	$248,193.10	
Subscriptions Earned	85,713.60	
Initiation Fees	27,428.75	
Miscellaneous Membership Income	1,328.08	$362,663.53
Publications		
Journal & Transactions Sales	38,348.35	
Journal Advertising	297,213.00	
Handbook Sales—1948	6,973.00	
Handbook Sales—1949	5,975.00	
Handbook Advertising	13,950.00	
Aeronautical Publications	20,458.69	
Special Publications	28,088.67	
Miscellaneous Publications	3,392.54	414,399.25
National Meetings		
Guest Registrations and Papers Sold at Meetings	8,451.25	
Dinners	25,255.25	
Displays	14,438.00	
Summer Meeting	6,822.00	54,966.50
Interest & Discount		
Interest Earned	11,092.09	
Discount Earned	359.88	11,451.97
Total Member Service Income		843,481.25
General Research Fund		55.46
Industrial Income for Technical Board Services—Exclusive of $18,988.16 Deferred		142,599.84
Total Income		$986,136.55

Expenses

Sections and Membership		
Sections & Student Branches	$ 13,967.06	
Sections Appropriations & Dues	50,578.00	
Membership	23,952.83	
West Coast Office	15,988.21	
Miscellaneous Membership Expense	1,716.48	$106,202.58
Pro-Rated Administrative Expense (15.1%)		29,533.71
		135,736.29
Publications		
Journal & Transactions Editorial	137,110.15	
Journal Advertising	129,171.68	
Handbook Mailing—1948	505.77	
Handbook Editorial—1949	44,847.62	
Handbook Advertising	3,002.34	
Aeronautical Publications	13,353.36	
Special Pubilcations	12,144.11	
Miscellaneous Publications	25,102.43	365,237.46
Pro-Rated Administrative Expense (52.0%)		101,705.47
		466,942.93
National Meetings		
Department Expense	31,448.36	
Cost of Registrations and Papers	2,753.29	
Meetings	27,789.14	
Dinners	21,066.97	
Displays	4,801.28	
Awards	1,087.80	88,946.84
Pro-Rated Administrative Expense (12.6%)		24,644.02
		113,590.86
Total Member Services Expense		$716,270.08
Technical Board Services		
Technical Committee Operations	$110,962.91	
CRC Appropriation	25,000.00	
Miscellaneous Expense	6,636.93	142,599.84
Pro-Rated Administrative Expense (20.3%)		39,704.25
		182,304.09
Total Direct Expenses	702,986.72	
Total Administrative Expenses	195,587.45	
Total Expenses		898,574.17
Net Unexpended Income		87,562.38
Total Income		$986,136.55

mittees had been published—or were in process—when 1949 ended.

Three factors combined to bring about this result: (1) the total number of papers presented before National and Section meetings declined; (2) the total pages in Quarterly Transactions were increased from 668 in 1948 to 680 in 1949; and (3) the percentage of presented papers approved for publication dropped from 25.4% in 1948 to 19.8% in 1949.

The criteria for approval of papers were not modified during the year.

SAE Special Publications

More than 100,000 copies of SAE papers and technical committee reports were distributed by the Special Publications Department during 1949, with a more favorable income-to-cost ratio than in any previous year.

The headquarters library, which functions primarily as a source of special information on SAE material, was incorporated as a function of the Special Publications Department during the year and has made extensive revisions in files and indexes to permit quicker and more accurate acquirement of necessary information.

Public Relations Aim Steady

Public relations activities continued to aim primarily at creation of favorable impressions about SAE among executives of the industries from which the Society draws its membership and among members and prospective members. More outside editors and reporters than ever before asked for and received information and data from SAE for use in special articles and columns.

Cooperation with student development work was continued and intensified, both in relation to SAE's own publications and outside magazines and newspapers.

Continued on following page

BALANCE SHEET — As at Sept. 30, 1949

In Agreement with Haskins & Sells Audit

Assets	
Cash—Unrestricted	$174,677.36
Restricted	13,402.90
Notes & Accounts Receivable—Less Reserves	14,940.05
Securities—Cost Value	501,993.00*
Accrued Interest on Securities	3,476.83
Inventories	977.24
Deposits	550.00
Furniture and Fixtures	1,000.00
Deferred Charges and Prepayments	38,788.85
Total Assets	$749,806.23
Accounts Payable	$ 11,296.68
Section Dues Payable	3,881.00
Deferred Credits to Income:	
Member Dues Received in Advance	84,347.63
Industrial Income for Technical Board Services	41,948.16
Subscriptions	16,429.83
Others	10,464.63
Reserves for Unexpended Contributions	9,975.51
Reserve for Retirement Plan Contributions	13,041.22
General Reserve	558,421.57
Total Liabilities and Reserves	$749,806.23
Accounts Receivable—Member Dues and Fees	
Total Unpaid at above dates	$ 24,301.80
Less Reserve for Doubtful Dues	24,166.80
Net Receivable	$ 135.00x

* Book Value—(Quoted Market or Redemption Value 9/30/49—$493,445.48)
x Unpaid Transfer Fees

Society's Finances Reflect Basic Strength

The Society's membership accepted the new dues schedule in its stride and made dues and fees the principal source of SAE income—going ahead of advertising revenues for the first time in several years.

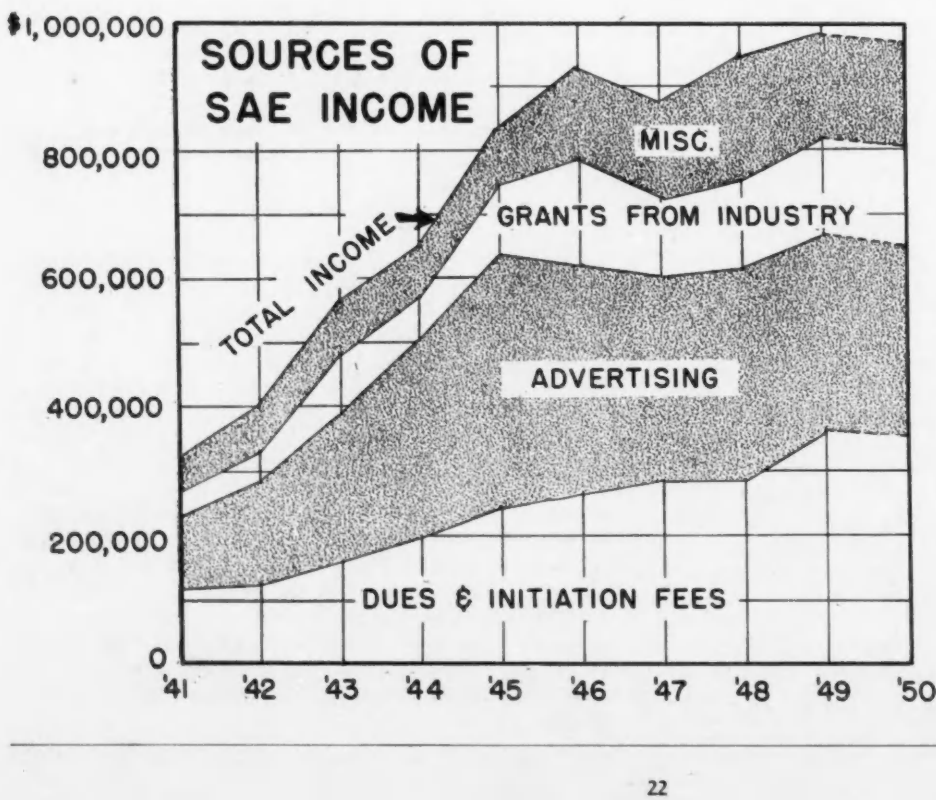
Industry, in turn, strongly endorsed the SAE Technical Board program by providing funds slightly in excess of requirements for the second straight year.

Unexpended income of $87,000 has been added to reserves which are now $558,000—70% of the goal set by the SAE Finance Committee. In turn, the excess Funds From Industry have been earmarked as deferred income for that work.

As for the future, the new budget contemplates a black figure of some $65,000—made possible by increased revenues from dues plus a vigorous pursuit of ways to hold down internal expenditures.

Continuation of the current level of national economy for about three additional years should put SAE in an enviable position to meet whatever shocks the future may deliver. Especially is this true because of the comparative stability provided through having membership dues, rather than unpredictable advertising revenues, as the principal income factor.

The inherent soundness of our present position is reflected in the figures on pages 21 and 22 of this report. The relationship of our major sources of income is shown in the chart below.



James C. Zeder

SAE PRESIDENT for 1950

AN "engineer's engineer" is the expression often used in describing James C. Zeder, Chairman of Chrysler Corporation's Engineering Board, who is SAE President for 1950.

Since he entered the automotive engineering field 27 years ago, he has built an enviable record of achievement.

Management of Chrysler's diversified engineering laboratories was assigned to him 16 years ago by the famous Fred M. Zeder-Carl Breer-O. R. Skelton engineering team . . . and today reflect his and their constant insistence on thorough experimentation and testing.

Born April 17, 1900, in Bay City, Mich., he was the youngest of five boys and one girl. He delivered papers and helped out in a local store during grammar school days. Then, while completing high school in 3½ years, he worked during vacations in various Bay City machine, pattern, and forge shops —and in a foundry and on an assembly line in Detroit.

He enlisted in the U. S. Army in June, 1918, and the next year, after demobilization, enrolled in the engineering school at University of Michigan. There, credit for summer vacation work in machine shops made him eligible for graduation in 3 years, but he continued for an extra term to take additional subjects he considered necessary to a thorough engineering background. Graduated in 1922 with a B.S. degree, he started to work on Maxwell's final assembly line. Four months later he became a draftsman for Handley Knight. Next came a period with Timken Roller Bearing Co., where he organized Timken's first engineering laboratories, before rejoining Maxwell as an engineer in the mechanical laboratory.

Later, he became head of that laboratory, stayed with the organization when it became Chrysler Corp. in June, 1925, and went on to become chief engineer of Plymouth and DeSoto Divisions in October, 1928. By 1933, he was chief engineer of all Chrysler laboratories—and assumed his present post as Chairman of the Chrysler Engineering Board at the time the Board was first organized in May, 1946.

At his home in Bloomfield Hills, Jim Zeder has a completely equipped woodworking shop in the basement, where he turns out furniture that friends declare compares with the work of most professional craftsmen. Almost every spare daylight hour during the warmer months, he devotes to tending the fine flower and vegetable gardens and the orchard of apple trees on his 8 acres of land . . . and his chickens supply the eggs for his breakfast table.

Somehow he manages to find time for photography, too. He does fine work in both still and moving pictures. He is also interested in antiques and is not easily fooled when it comes to good paintings and rare porcelains.

He holds an honorary master's degree from Lawrence Institute of Technology, a doctor's degree from University of Dayton, and is president of the Chrysler Engineering Institute. He is a member of Tau Beta Pi, Sigma Xi, the Newcomen Society, and the Franklin Institute. He is the author of "Making the Most of Engineering," for which there have been more requests than for any other paper presented before SAE. To young engineers striving to get ahead in the automotive field today, he offers two necessary qualifications: "imagination and a lot of common sense."

In 1940, when war clouds were gathering, Jim Zeder conceived and stimulated organization of the SAE War Engineering Board. For the next six years as its chairman, he organized and directed the work of this primary SAE war agency—which, at the peak of its wartime service, had working committees whose membership totaled more than 800 of the country's top automotive engineers. Later, he was a member and then chairman of the SAE Technical Board, which has supervised all SAE technical committee activities since its postwar establishment.

COUNCIL

G. E. Burks

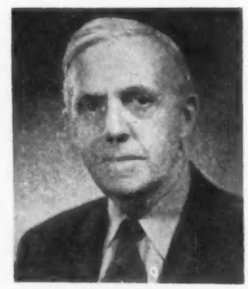
Norman H. Daniel

Earle A. Ryder

B. B. Bachman

R. J. S. Pigott

Completing the 1949-1950 term as councilors are G. E. Burks, Caterpillar Tractor Co.; Norman H. Daniel, General Motors Products of Canada; Earle A. Ryder, Pratt & Whitney Aircraft. B. B. Bachman, Autocar Co., serves again as treasurer. R. J. S. Pigott, Gulf Research and Development Co., and S. W. Sparrow, Studebaker Corp., continue on the Council as past-presidents. All vice-presidents representing activities also serve on the Council. Shown below are the three new councilors.



S. W. Sparrow

William E. Conway

William E. Conway has climaxed a long career in the truck business with five years as Assistant Director of Studebaker's National Accounts Division.

He started back in 1914 as Manager of the Garford Truck Co.'s St. Louis service branch. Ten years later he was Vice-President of the company. He stayed with Garford until 1929, when he joined the Atterbury Motor Car Co. as Vice-President.

In 1931, he went to Studebaker as Assistant Sales Manager, Pierce Arrow Motor Truck Division. Since, he has had various assignments in Washington and New York. He was Chairman of SAE Metropolitan Section for 1946-1947.

Philip J. Kent

Philip J. Kent has been associated with Chrysler for nearly 30 years. He started as an electrical engineer for the Chrysler division of the Willys Corp. in 1920, continued when it became the Chrysler Corp., and is now Chief Engineer of Chrysler's electrical division.

Previously he had worked for Studebaker and the Western Electric Co. He was graduated from Cornell with the M.E. degree, having specialized in electrical engineering.

He was successively Secretary, Vice-Chairman, and Chairman of SAE Detroit Section in the period 1928-1931. He is a member of the SAE Electrical Equipment and Lighting Technical Committees and is Chairman of the Vehicle Radio Interference Subcommittee.

Dale Roeder

Dale Roeder served on the SAE Council before when he was SAE Vice-President representing Truck and Bus Activity in 1948. He has been a member of numerous SAE committees.

At the Ford Motor Co., where he is now Executive Engineer, he was Chief Engineer for all commercial vehicles for several postwar years and was wartime Assistant Chief Engineer having charge of all military wheeled and track-laying vehicles produced for U. S. Army Ordnance. From 1929 until 1941 he was Truck Engineer. Earlier he had worked on the changeover from the Model T to the Model A and on chassis drafting.

VICE-PRESIDENTS

Raymond D. Kelly
Vice-President, Air Transport Activity

Raymond D. Kelly entered the instrumentation end of the aircraft business 25 years ago and branched out from there.

Fresh from Purdue, he joined an Army Air Corps instrument unit at McCook Field in 1925. There, and at Wright Field, he worked on pitot tubes, altimeters, and fuel level gages for three years. Then he joined the American Paulin System, Inc. to work on a very sensitive aerial-survey altimeter.

In 1930, he took charge of the Boeing Air Transport Corp.'s instrument shop. Ever since the company became part of United Air Lines in 1936, he has been doing long-range development and testing. Now he is Superintendent of Technical Development.

Harold D. Hoekstra
Vice-President, Aircraft Activity

Harold D. Hoekstra has had over 20 years of aeronautic experience in government and industry. For three years he has been Chief Engineer of CAA's Aircraft Division. During the war he directed CAA participation in the glider conversion program and did liaison work for CAA with the Air Force.

His industry experience includes airplane design work with the Crosley Aircraft Co., Ford Motor Co., Curtiss Aeroplane and Motor Co., and Stinson.

Hoekstra has served on numerous SAE technical and activity committees and last year was Vice-Chairman of the IAS Washington Section. He has been an active pilot for years.

Wright A. Parkins
Vice-President, Aircraft Powerplant Activity

Wright A. Parkins has had charge of all the activities of Pratt & Whitney Aircraft's engineering department, including development of all piston and turbine engines, since 1944. He joined the company in 1928 to direct test-house and flight testing, then rose through several posts to his present position as Engineering Manager.

Earlier he had worked at McCook Field in Dayton, first as a representative of the Almen Barrel Engine Co., and later as a civilian planner of the Army Materiel Division's aircraft-engine test laboratories. He received his engineering degree from the University of Washington.

Rex A. Terry
Vice-President, Body Activity

Rex A. Terry has devoted his working life so far to body engineering. He is now Assistant Chief Engineer, in charge of body design, of Chrysler Corporation's commercial car division.

He has put much of his spare time into studying aerodynamics, body construction, and business management and into SAE activities. Terry is a member of the SAE Passenger Car Body Technical Committee and, for two years, has been Chairman of the Body Activity Meetings Committee. In Detroit Section, he has served as Vice-Chairman representing the Body Activity.

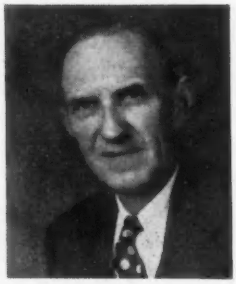
VICE-PRESIDENTS

Albert H. Fox
Vice-President, Diesel Engine Activity

Albert H. Fox started in the oil business in China in 1929, the year after Purdue granted him his bachelor's degree. The Texas Co. China Ltd. assigned him to the North China territory, which he traveled extensively. He quit in 1936 and went back to Purdue for his master's degree.

The degree secured, he went to work for the Standard Oil Co. of Indiana at their Whiting Research Laboratory on evaluation of diesel fuels and engine test methods. He is now a Group Leader there, supervising work on diesel fuel, aviation gasoline, and jet fuels. He is active in SAE Chicago Section, national Diesel Engine Activity affairs, and CRC.

Roy W. Roush
Vice-President, Engineering Materials Activity



Roy W. Roush was appointed Chief Materials Engineer of the Timken Detroit Axle Co. in 1947 after he had been its Chief Metallurgist for 12 years.

Previously he had spent 13 years in metallurgical work at the Cadillac Motor Car Division of General Motors.

The Engineering Materials Activity owes its founding partly to him. Even before its existence, he had helped arrange many SAE technical sessions on the subject of materials. He has been a member of the SAE Iron and Steel Technical Committee, serving on a number of its divisions and working committees, and recently as its chairman.

Arthur O. Willey
Vice-President, Fuels & Lubricants Activity

Arthur O. Willey is Vice-President in charge of Engineering for The Lubrizol Corp. He started there in 1935 as a part-time consultant while he taught at the then Case School of Applied Science. In 1941 he resigned from Case to direct Lubrizol's engineering research on a full-time basis.

He went to Case in 1929 after instructing four years at the University of Maine, where he obtained his master's and bachelor's degrees.

Many technical papers on the testing and evaluation of engine and gear lubricants bear his name as author. He is active in the CRC Cooperative Lubricants Research Committee.

Edward N. Cole
Vice-President, Passenger Car Activity

Edward N. Cole, Chief Engineer of the Cadillac Motor Car Division, is the product of General Motors' own training program.

Under the GM Institute's plan of alternating work and schooling, Cole went to work first as a Cadillac laboratory assistant. After graduation he continued in engine development work for Cadillac and became Chief Design Engineer in 1943.

During the war, Cole handled the development that led to use of the Cadillac power train in light tanks. In 1944 he received the title of Assistant Chief Engineer and responsibility for starting the engineering program for postwar cars.

VICE-PRESIDENTS

Robert F. Steeneck
Vice-President, Production Activity

Robert F. Steeneck has represented the Fafnir Bearing Co. on the West Coast; handled its shackle division in New Britain, Conn.; served it as field development engineer in Detroit; and now manages its Cleveland district. He joined Fafnir in 1928, after representing the John W. Watson Co.

Cleveland Section has kept him on its governing board since 1940, naming him Membership Chairman, Advertising Chairman, Secretary, Treasurer, Vice-Chairman, and now Chairman. He has also been Chairman of the national Membership and Sections Committees and a Councilor. For SAE National Production Meetings, he originated the "clinic" idea and arranged the first two.

Wayne H. Worthington
Vice-President, Tractor & Farm Machinery Activity

Wayne H. Worthington began his career when farm tractors first appeared and has been advancing their use and design ever since. Following his graduation from Oklahoma A & M he helped apply American farm equipment and methods in European, Siberian, and South American agricultural areas.

After he returned to this country, he became Chief Engineer of The Aultman and Taylor Machinery Co. and later of its successor, the Advance-Rumely Co.—both early builders of steam engines, tractors, and heavy farm equipment. He joined John Deere Waterloo Tractor Works in 1930 and is now the Director of Engineering Research.

Matt E. Nuttila
Vice-President, Transportation & Maintenance Activity

Matt E. Nuttila has operated fleets almost ever since he received his degree in electrical engineering from Michigan State College in 1925. After three years of general shop and operating experience, he joined the Crew Levick Co. in 1928 as Assistant Superintendent of Motor Vehicles, later becoming Superintendent of Automotive Equipment. In 1937 he left to take over as Superintendent of Motor Vehicles for Cities Service Oil Co., his present position.

Besides heading Metropolitan Section's Diesel Activity and Membership and Meetings Committees, he has served on numerous national activity and technical committees.

William P. Michell
Vice-President, Truck & Bus Activity

William P. Michell joined Spicer Manufacturing, Division of Dana Corp., as Chief Development Engineer in 1946, bringing 30 years of production and design experience.

He started out with the Whitlock Manufacturing Co., makers of heat transfer equipment and was Assistant Shop Foreman before he left in 1920 to join Ace Motorcycle. There he was a methods engineer and later Shop Superintendent.

In 1924 he went to the Mack Manufacturing Corp., where he did production-engineering liaison work first, then took charge of designing new trucks, buses, fire apparatus, and, during the war, military equipment. He chairmans the SAE Motorcoach and Motor Truck Technical Committee.

Society of Automotive Engineers— A Story of Teamwork by Rivals

WHEN they study U.S. production methods, foreign industry officials almost invariably express surprise at the high degree of both competition and cooperation they find in American industry.

This mixture of rivalry and teamwork seems contradictory, but it's not.

For competition is what keeps each firm improving its products and production methods. And this progress is helped by the freedom with which engineers from rival firms exchange information on production methods and work together on industry-wide technical problems.

The Society of Automotive Engineers is one of America's best examples of this cooperative endeavor within a fiercely competitive industry.

When SAE was born in 1905, there were no "automotive engineers." Early members were mechanics, inventors, and technicians from other branches of engineering.

SAE was formed to help these men make faster progress in solving the many technical problems bedeviling the young industry. They met after working hours, to exchange ideas.

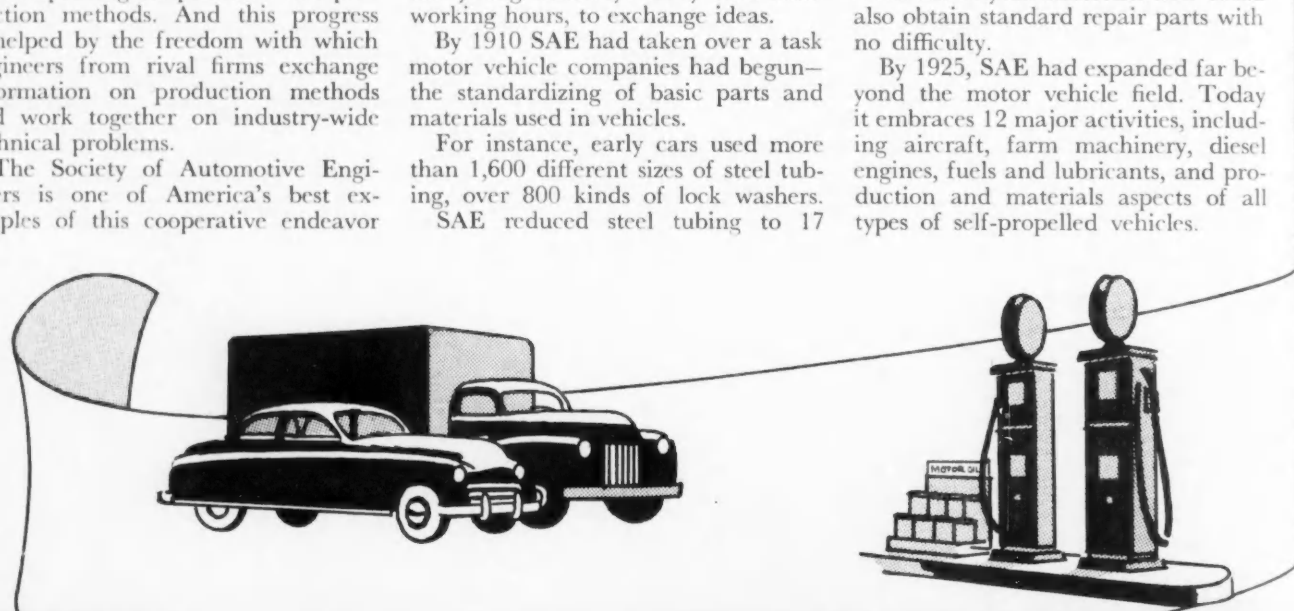
By 1910 SAE had taken over a task motor vehicle companies had begun—the standardizing of basic parts and materials used in vehicles.

For instance, early cars used more than 1,600 different sizes of steel tubing, over 800 kinds of lock washers.

SAE reduced steel tubing to 17 standard sizes; lock washers to 16 types. The same sort of results were attained in standardizing spark plug sizes, motor oil, bearings, alloy steels, and hundreds of other components.

The benefits were enormous. Because suppliers of automotive parts could concentrate on fewer basic items, vast cost savings were passed on to car buyers. Motorists now could also obtain standard repair parts with no difficulty.

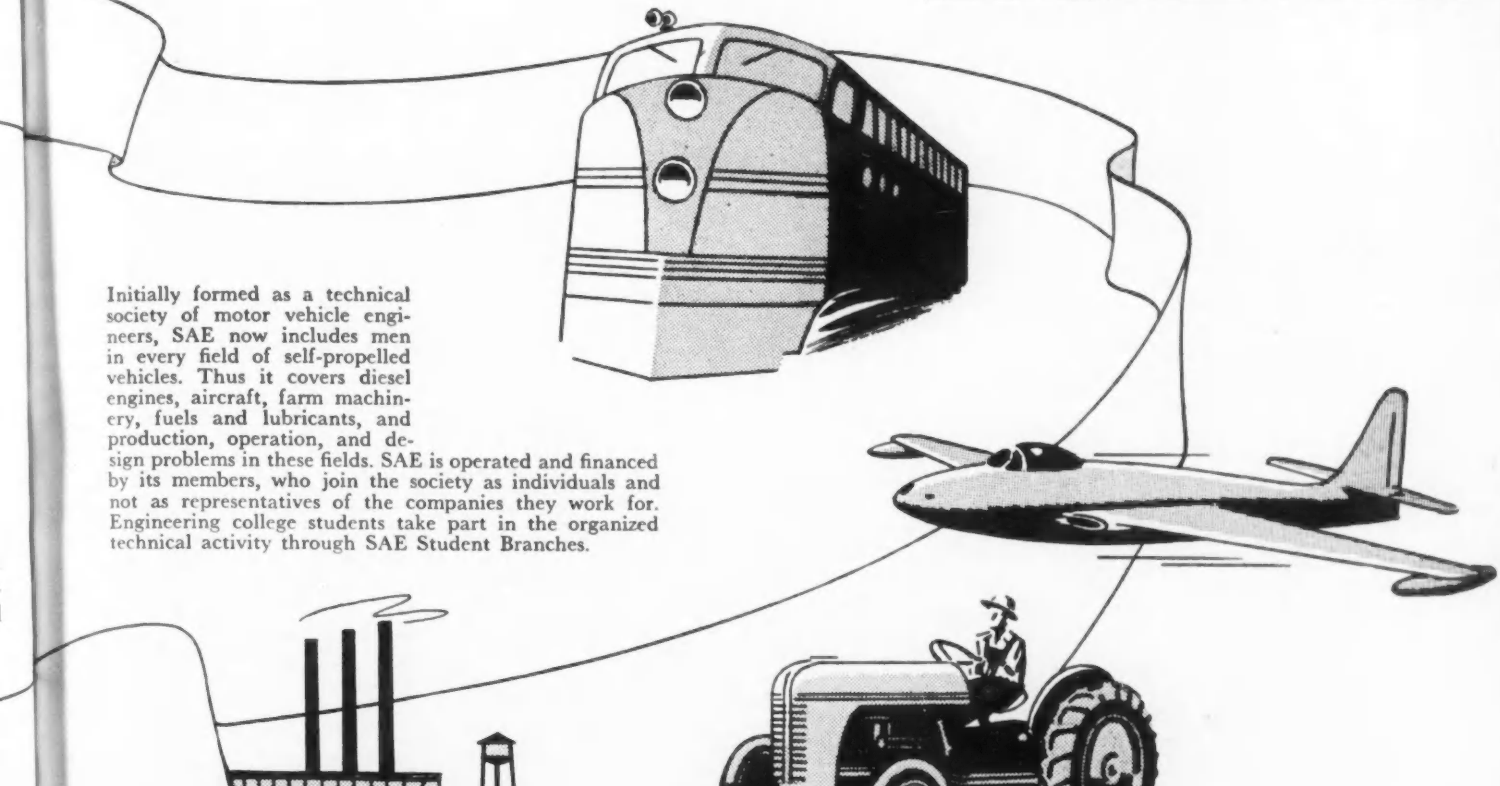
By 1925, SAE had expanded far beyond the motor vehicle field. Today it embraces 12 major activities, including aircraft, farm machinery, diesel engines, fuels and lubricants, and production and materials aspects of all types of self-propelled vehicles.



All motor oil is graded by SAE numbers, indicating viscosity.

Standard parts for repairs are another result of SAE work.

A Reprint from "Automobile Facts" Published by the Automobile Manufacturers Association



Initially formed as a technical society of motor vehicle engineers, SAE now includes men in every field of self-propelled vehicles. Thus it covers diesel engines, aircraft, farm machinery, fuels and lubricants, and production, operation, and design problems in these fields. SAE is operated and financed by its members, who join the society as individuals and not as representatives of the companies they work for. Engineering college students take part in the organized technical activity through SAE Student Branches.

The yearly *SAE Handbook* sets forth standards and recommended practices on more than a thousand different classes of items. Acceptance of these standards is entirely optional in industry. But their values are so obvious that they are almost universally used.

From 30 original members, SAE's ranks have grown to almost 16,000 today, extending over all 48 states and into many foreign lands. Regular monthly technical meetings are held in 38 U.S. cities. The various industry groups within SAE each hold national meetings annually.

The technical discussions of these meetings are reported in SAE's monthly *Journal* and its *Quarterly Transactions*, to keep engineers abreast of all new techniques in their fields.

SAE also serves industry through special technical committees, set up for specific research projects on manufacturing processes, materials, design problems and so on.

One current project, for instance, is to develop a manual for automotive draftsmen, to be used in the industry and in engineering schools. Already three years under way, the project is expected to save industry a few million dollars a year by ending confusion in drafting practices.

This technical committee work is the only activity for which SAE accepts industry funds for a portion of its operating cost.

In both world wars, SAE mobilized engineering talent for special service. In World War I, SAE took part in developing the Liberty aircraft engine. And from 1939 to the end of World War II, SAE committees were engaged in a total of 1,400 projects for the armed services.

Working with rehabilitation officers, SAE developed and arranged for production of the special mechanical driving aids which enable handicapped veterans to operate motor vehicles.

Today SAE is doing studies on jet aircraft engines, gas turbines and helicopters. It is working to end automobile interference with home television reception. It is making studies of engine performance in sub-zero climates, and is carrying on scores of other projects of both military and peacetime value.

It provides a vivid example of how American industry can share its technical knowledge freely without sacrificing the competitive drive which, in war and peace, keeps industry improving its services to the nation.

DR. HOBART CUTLER DICKINSON, president of SAE in 1933, died on Nov. 27, 1949, at Doctors Hospital in Washington, D. C. He had celebrated his 74th birthday on Oct. 11.

Dr. Dickinson was recognized as one of the country's leading scientists long before his retirement from the National Bureau of Standards in October, 1945. Outstandingly an authority in the fields of thermodynamics and internal combustion engines, no technical phase of automobiles or aircraft was without attraction for his talents. His interests were widely catholic, his mind alert and constructive in economic as well as engineering thinking.

As SAE president in the depression year of 1933, he talked to Section after Section on "The Mechanics of Recovery", emphasizing that "We should get nowhere in science or engineering if problems were handled in the manner in which economic problems have always had to be handled."

As he intensified his interest in automotive industry problems, the breadth of his scientific attack resulted in measurable contributions on such varied topics as headlight research, fuel economy, engineering research, engineering management, tire design, riding comfort criteria, and traffic safety. In a paper on "Speed, What Is Safe?", he set down a definition for "safe speed" which has often been quoted in subsequent years: "No vehicle shall be operated at a speed such that it cannot be stopped in the assured clear distance ahead."

Dr. Dickinson spent his entire professional career at the National Bureau of Standards, except for the 1921-1923 period when he was SAE research manager. He joined the Bureau staff as a physicist in 1903 and engaged immediately in experimental laboratory work on problems of heat, temperature, thermometry, and thermodynamics of internal combustion engines. He had just completed his studies at Williams College where he was granted both A.B. and M.A. degrees. In 1910 his Ph.D. was conferred by Clark University.

By the time he was elected to membership in SAE in 1918, he had already contributed many valuable technical papers to engineering and scientific groups—and evidenced his widespread professional interests by membership in the Society of Refrigerating Engineers, The American Association for the Advancement of Science, the American Physical Society, the French Physical Society, and the American Society for Testing Materials. Later he became a member of the American Society of Mechanical Engineers, American Society of Research Engineers, American Philosophical Society, and the Washington Academy of Sciences.

From 1915 to 1918 his time at the Bureau was devoted entirely to fundamental problems of aeronautic engines and accessories, construction and operation of the altitude laboratory, and direction of special investigations of aeronautic radiators, ignition devices, and other parts. In this period, he built and put into operation the first altitude chamber for testing aircraft engines.

In SAE, before his election as president, Dr. Dickinson participated actively in scores of technical committee operations, represented the Society on many committees functioning jointly with other engineering groups, and played a particularly active part in the research work of the Society. He helped to organize the Washington Section of the Society and in 1920-21 became its first chairman.

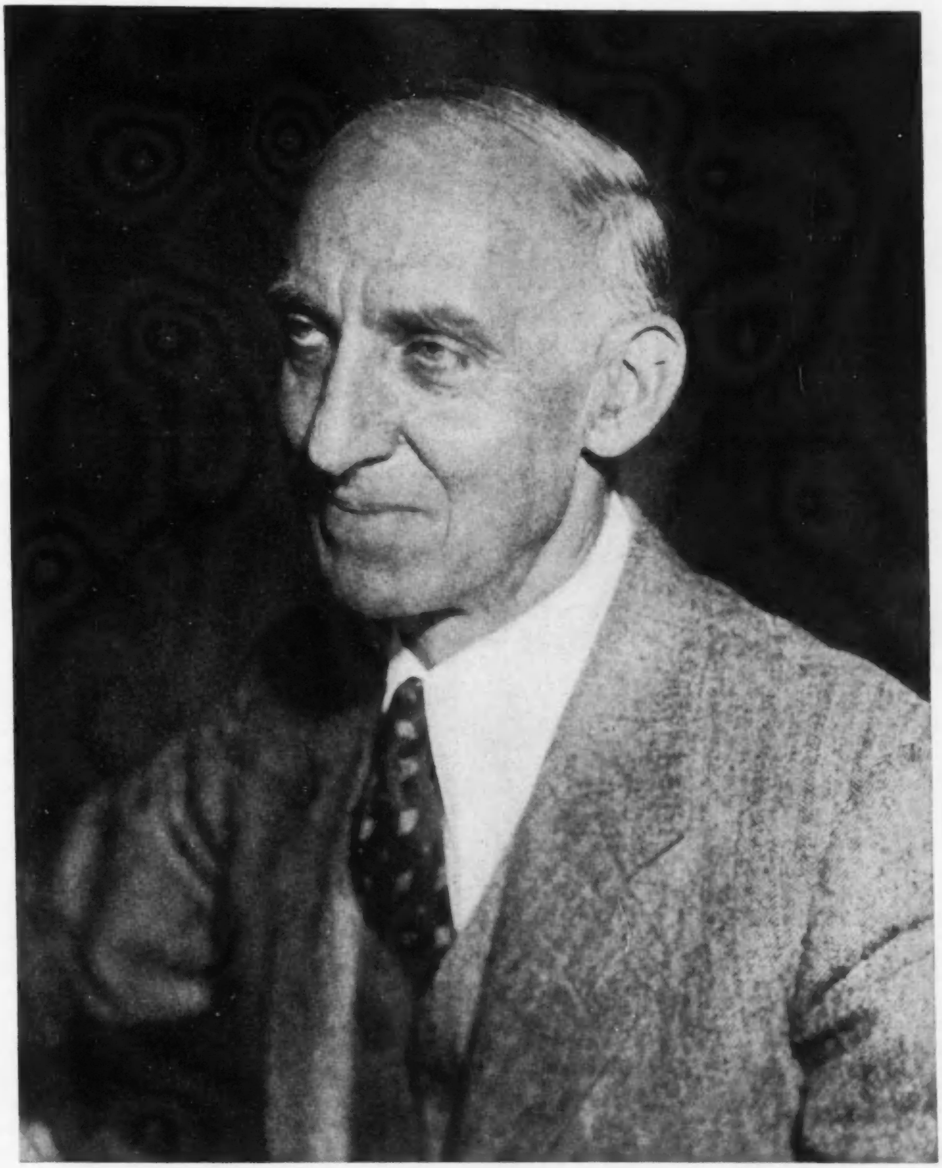
At the Bureau, he became physicist in charge of powerplant research; then, in 1922, chief of the heat and power division, the post which he held at the time of his retirement. He was honored on the occasion of his retirement by a dinner attended by more than 300 friends and distinguished scientists. Thereafter he continued to cooperate with the Bureau in a consulting capacity.

Notably vigorous physically throughout his life, he devoted considerable vacation time to exploration, mountain climbing, and out-of-doors activity.

He was a member of the Cosmos Club, the Appalachian Trail Club, The Williams Club, and the Westmoreland Congregational Church.

Surviving are his wife, Mabel K.; a daughter, Mrs. Hugh N. Ross; and a son, Lt. Bradley W. Dickinson, USN.

Dr. Dickinson was born at Bangor, Maine, in 1875.



Dr. Hobart Cutler Dickinson

(1875–1949)

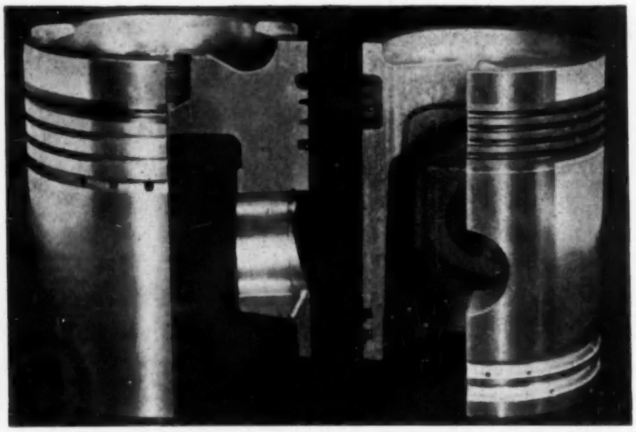


Fig. 1—These bimetallic pistons are built of aluminum, with cast-iron inserts for the ring area

BIMETALLIC Gives New

ALUMINUM-CAST-IRON bimetallic construction offers many attractive automotive applications, provided limitations imposed by the difference in cofficients of expansion of the two metals are considered. Parts such as long-lived bimetallic pistons, gears, bearings, and light-weight housing castings and better performing brake drums have been built and are operating successfully.

When designing for the process for making bimetallic parts (see box on p. 34 for process description), characteristics of the bond (which is molecular) between the two metals must be kept in mind. The bond is strong, and very hard—of the order of 875 Vickers diamond Brinell. Pull-test specimens show a bond tensile strength of from 10,000 to 17,000 psi and a shear strength of 600 and 8000 psi.

Second item we cannot overlook is the fact that the coefficient of expansion of most aluminum casting alloys is about twice that of most ferrous alloys.

If we are going to dispose a considerable body of aluminum about a strong ferrous insert, we must make certain that the application is not used at a sufficiently high temperature to cause undue stresses at the bond line due to the difference in thermal expansion. And if the aluminum is poured so that the bond is on the inner diameter of the ferrous piece, there must be sufficient restraint imposed by the cores to offset the stresses that would occur during cooling. Because of the bond's low ductility, designs which would tend to stress the bond in impact also must be bypassed.

The aluminum-iron construction can be most useful to both engine designer and user in the bimetallic piston, Fig. 1. It combines the resistance to both wear and high-temperature operation of cast iron for the ring band area, and at the same time, the lightness of aluminum for the body of the piston.

Eighty percent of the wear on piston-ring grooves is in the vicinity of the top groove. Top rings from aluminum pistons recently taken from a torn down engine were from 0.015 to 0.030 in. loose in the groove while the other rings were reasonably tight. This can cause many troubles . . . excessive blowby, high oil consumption, and sometimes even burning. A bimetallic piston seems to be the answer to this.

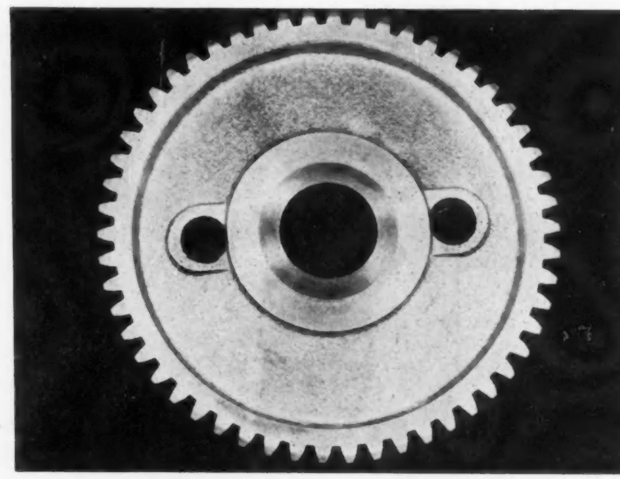


Fig. 2—This aluminum timing gear has a bonded-in steel hub

A bimetallic piston in which the band containing at least the top ring was made of a ferrous material would be more resistant to deformation in operation. Such a piston would not only have longer life, but also would permit engine designers to reach higher bmep values.

This type of piston is not a new idea. To my knowledge more than 50 patents have been issued in this country alone on mechanically-joined bimetallic pistons of this type. But none of them is molecularly bonded and none of them has been fully successful. When a ferrous alloy of low coefficient of expansion is disposed about aluminum of higher coefficient of expansion, the tendency will be for the aluminum to grow against the restraining iron band during a seating cycle. This may minutely upset the aluminum so that when it cools, the fit will not be as close as it was originally. Subsequent heating cycles will exaggerate this condition until the ring band itself loosens on the piston.

With the bonded construction relative motion at the interface is eliminated and the construction will maintain original tightness throughout its life. A

BONDING
Parts Design Possibilities

BASED ON PAPER* BY

Charles E. Stevens, Jr.

Chief Engineer,
Alfin Division,
Fairchild Engine and Airplane Corp.

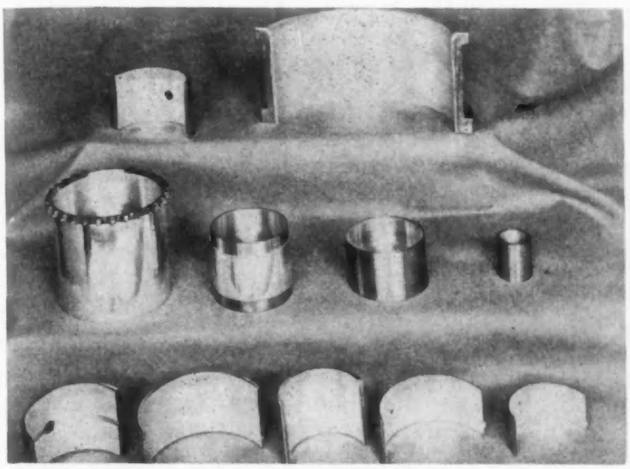


Fig. 3—Several types of steel-backed, bonded aluminum bearings

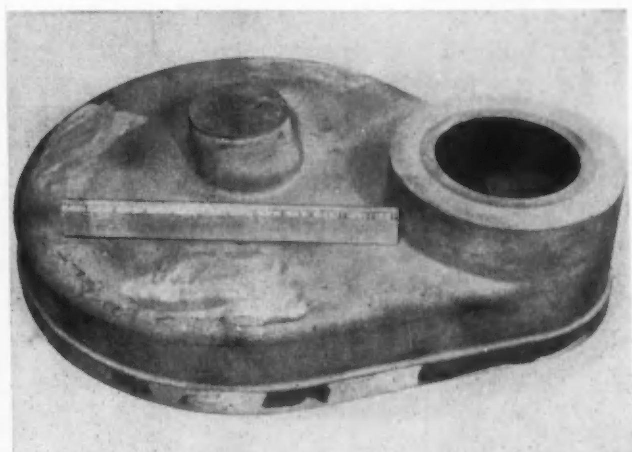


Fig. 4—A large reduction gear housing with a bonded-in steel bearing cage

technique has been developed which will permit the casting after pouring to attain room temperature without bond failure. By using either high-nickel cast irons of high coefficient of expansion, or gray irons of low modulus, the differences between the contractions of the two metals from casting temperatures can be so controlled that the bond strength will not be exceeded; therefore, the bond will be maintained during the initial cooling from casting temperature.

There is virtually no stress at the bimetallic interface of a bonded piston made of Alcoa 132A (Lo-Ex) alloy and a Ni-resist insert, the assembly being cast in a permanent or semipermanent mold. This conclusion stems from extensive experience in the sectioning of such bimetallic pistons, with frequent microscopic and zyglo examinations. I believe the reason for this is that the cores exercise a certain restraint upon the shrinkage of the assembly, enough in fact to overcome the slight difference in thermal coefficients of expansion.

At present, field tests are being made in various parts of the country on several hundred bonded bimetallic pistons, ranging in size from a 9 × 11-in. locomotive-type diesel piston to several 4 and 5-in diameter pistons for tractor, truck, and bus use.

On one particular type of diesel engine, bimetallic pistons were substituted for cast-iron pistons furnished as original equipment. These pistons are still on test and are close to the 200,000-mile mark, whereas 25,000 miles was the average life expectancy of the all-aluminum pistons previously used. A general analysis of field testing to date seems to indicate that twice to three times the piston wear can be expected from the bimetallic as against the all-aluminum piston.

Second item of interest to the engine designer is the bimetallic timing gear, shown in Fig. 2. This is a straightforward application of the bimetallic

* Paper "The Uses of Bonded Bimetallic Components in Modern Automotive Structure and Engine Design," was presented at SAE Metropolitan Section, New York, Oct. 4, 1949. (This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

construction, with no casting design problems arising from the difference in coefficient of expansion of the two metals. Fact that the aluminum contracts more than the iron in cooling from casting temperatures seals the bond that much more. A gear of this type is not expected to operate at a temperature high enough to make this automatically-achieved shrink fit diminish greatly.

In an extensive test program, a large engine manufacturer found that a cast-in, but not bonded-in insert would loosen in time; the bonded hub did not. It was also found that the strength of this type camshaft gear, cast in "Y" alloy and suitably heat-treated, compared with a cast-iron gear; the noise level of a carefully machined and shaved aluminum gear was comparable with a run-of-production fiber gear and had at least three times the potential wear life and strength.

Many thousands of these gears are in service today. And despite the fact that in most of them the hub is perfectly round—with no knurling, serrations, slots, or irregularities of any kind—none has ever failed at the bond line. These gears are original equipment on two widely used truck engines and are on test, in both the field and laboratory, by other truck and engine manufacturers.

Another program currently in the active development stage is that of the steel-backed, bonded aluminum bearings. See Fig. 3. Certain aluminum-tin alloys have bearing qualities second to none.

Under not too great loads, solid aluminum bearings are notably successful. As the loads increase, however, it is necessary to add hardeners—such as copper—to the bearing alloys, which to some extent reduces their effectiveness as bearing materials. And if the loads go higher yet, the property of conformability, which makes aluminum a good bearing material in the first place, is apt to lead to its failure in this heavy type of operation.

It is in this type of marginal operation that the advantage of the steel-backed aluminum bearing becomes important.

Here we have only 0.010 to 0.015 in of aluminum bonded to a steel shell. Hardeners do not have to

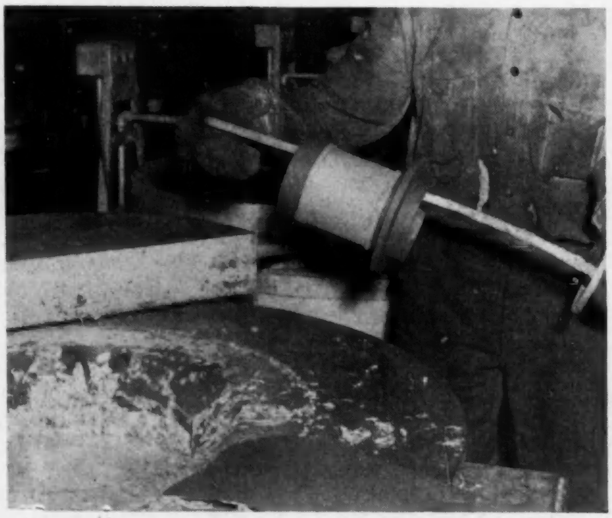
How Aluminum Is Bonded

Bonding of aluminum to iron is a casting process—not a welding, plating, or joining process in which two fabricated components can be made independently and then joined. A description of the process for producing the bimetallic aircraft engine cylinder barrel brings this out.

A suitably cleaned ferrous liner (in A) is immersed in a bath of molten aluminum (in B). When the ferrous part has attained the heat of the bath, it is attacked by the molten aluminum and an aluminum-rich alloy forms at the interface. The part is now wet or tinned with this aluminum alloy. (See C.)

The ferrous part now is removed from the metal and placed in mold and the aluminum casting alloy poured about it. See D. This poured aluminum fuses with the still molten coating on the hot ferrous piece. Upon cooling we have an intermetallic compound of aluminum and iron alloyed on the one side of the ferrous member and on the other side, the casting alloy suitable to our needs.

Next the muffed liner is sent to the machine shop where the fin design, shown in E, is machined. Note that had a fin design of greater pitch and greater fin cross-section been feasible from the standpoint of cooling effectiveness, it would have been possible to cast the fin design and save a machining operation.



A

B

be used in the bearing alloy and the advantage of high coefficient of heat transfer and good embedability are maintained unimpaired, with the steel back carrying the major part of the load.

Several hundred of these bearings are on test throughout the country and development searching for quick and economical manufacturing methods is rapidly going forward.

The fourth bimetallic component, a housing casting to replace cast iron, Fig. 4, is particularly timely with regard to the present tendency toward weight reduction in transport design. In constructions of this type, where conformability or lack of resistance to abrasive wear might have heretofore curtailed use of aluminum, now an aluminum casting with an iron or steel bonded-in insert, which is vibration-proof and leak-proof, might well be used.

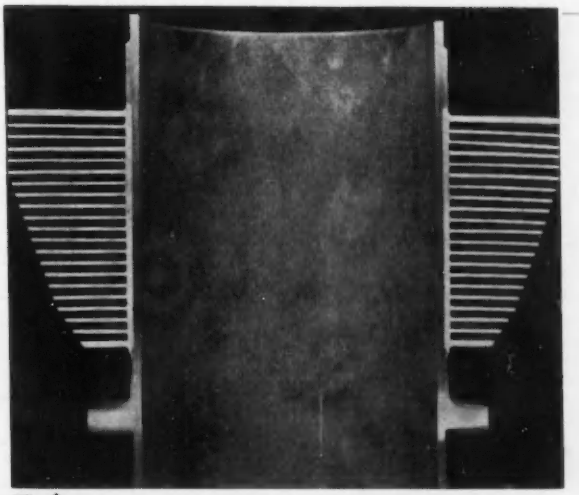
On one application alone during the war the use of a bimetallic casting of this type would have saved many thousands of dollars. An insert of an alloy steel could have been bonded into a housing to accept a heavily loaded main shaft roller bearing. Since this was for an aircraft engine, a cast-iron housing could not be considered and it was necessary to use a bolted-in bearing cage. The cage was difficult to machine and because of the ±0.0005-in. concentricity required, heavy scrap losses resulted due to machining errors.

With the bimetallic construction, a steel of the same analysis as the cage, bonded in position, could have been machined from the same dowel holes used in locating all other machining with no loss in concentricity. This would have greatly reduced manufacturing costs and produced a necessarily sounder construction.

A development quite similar to the aircraft cylinder barrel is the bimetallic brake drum. (For a discussion of this program, see SAE Journal, Vol. 57, November, 1949, pp. 56-61: "Aluminum-Iron Drum Boosts Vehicle Performance," by C. E. Stevens, Jr.) With proper cooling, it is possible to dissipate heat rapidly enough so that a heat exchanger rather than a heat reservoir type of construction increases the overall effectiveness of the brake.

to Iron

Incidentally, an interesting example of the heat transfer of a bonded bimetallic article as compared with one of steel was shown in tests run on a bimetallic cooking utensil. A 0.025-in. thick stainless steel frying pan with 0.100 in. aluminum bonded to the bottom was heated by a single pin-point Bunsen flame exactly at the center. Temperature readings were taken at points on a circle of 4 in. radius and showed a uniform temperature drop of only 50 F, from 300 F at the center to 250 F at the point of measurement. A similar test under identical conditions made on an all-stainless steel frying pan 0.065 in. thick gave a temperature drop of 180 F.



E ↑

C

D

Services Need PERFORMANCE

EXCERPTS FROM DISCUSSION* BY

Rear Admiral A. M. Pride, U S Navy

Chief, Bureau of Aeronautics

Here are answers Admiral Pride prepared, as part of the panel discussion on "Basic Problems of Producibility," to questions put to him by Roy Shoults, general chairman of the producibility panels at the SAE National Aeronautic Meeting in October.

Also part of this panel were a definition of produci-

"What constitutes good balance between overall functional performance and quantities of airplanes?"

As to that, of course, the balance which is desired is the one which will provide the maximum number of effective wartime flights.

From this point I begin to have my difficulties. To be effective, wartime flights must damage the enemy more, proportionately, than they damage us. And, aside from the comparative damage, our superiority in performance or numbers or both has to be maintained at a level which will keep our morale above the point of diminishing returns. (Courageous as we may be, we are still not a kamikazi nation, and I hope that we never will be.)

Of the two essential factors in this formula which I am trying to evolve, superiority in performance would seem to be the dominant one in the early stages of a war. Certainly, we are not going to start the hostilities, and, equally certainly, the enemy is not going to start them until he is sure that he can lick us. That is the way it has been the last two times, and that is the way it will be the next time. He will be in a pretty good position to judge the situation airwise, because he will know precisely from our Congressional Record how many airplanes we have built, while we will still be guessing at his inventory and potential.

In such case, our pilots' morale will be all-important. If the individual pilot does not feel that he has a good fighting chance material-wise, confidence in the manufacturers, in the materiel services, and in the administration itself will be shaken or destroyed.

While we should be developing and building new planes we will be harrassed by demands for reorganization and reoriented design, all to the detriment of our defense. We all have seen the elements of such situations in our experience so I need not be specific.

After the war is well underway, and we have been able to judge the comparative situations, we may be able to modify functional performance in the interests of quantities of airplanes, but I believe that we must have all of the performance we can get, even at the expense of numbers, until we see what the other fellow has. Efforts to arrive at quantitative results through mathematical analyses are valuable and, if sufficiently complex, can give impressive answers as to probability of losses, which will indicate penalties to be expected as performance decreases. The difficulty in the application of such analyses lies in the fact that reasonable decrements of performance do not, necessarily, improve producibility nor can they take accurate account of pilot morale on either side.

In short, there should be no compromise of overall functional performance in the interests of quantity until you can make a good estimate of what the opposition has in both respects. Thereafter, you can adjust performance, if adjustment is required, in the interests of quantity, but no decrements can be accepted beyond the point at which the individual pilot feels that he has a better-than-even chance of survival.

"What are the effects of military planning and service testing on M-Day producibility?"

That, I think, is putting the cart before the horse. M-Day producibility probably affects military planning more than planning affects producibility. As most of you know, the M-Day schedules produced by the Munitions Board cannot be arrived at except

PLUS PRODUCIBILITY

bility by Major-Gen. F. M. Hopkins, Jr., USAF, excerpts of which appeared in the November issue of SAE Journal, and discussions of airframe and engine manufacturers' producibility problems by H. L. Hibbard and E. B. Newill, which are digested on p. 42 in this issue.

after careful consideration of producibility. In the nature of things, the operators demand M-Day quantities of everything, including airplanes, that, in the first go-around are beyond the capabilities of production. Their plans must then be shaded to meet the actual potential, which, of course, is governed by producibility. There can be no denying that an operator's demand for an especially large and impossible number of a particular article causes the interested agency to heave 'round and attempt to improve M-Day availability through simplified production, but I still think producibility goes a long way toward dominating the planning, rather than the other way around.

Service testing does not, I fear, improve producibility. As an old service tester, my experience has been that, usually, defects have been cured by complicating, rather than simplifying structure or apparatus. Such complications have been necessary to make the article fit for service use, but man — being made as he is — usually tries in his service-test article to get by with as little as possible and then works up, material-wise, to an acceptance. The opposite process, whereby the manufacturer puts too much structure or equipment in to start with is quite rare, since he sees no advantage in starting with weight penalties. Airplanes always become heavier, anyway.

Service testing does not improve M-Day producibility but it certainly does insure the performance, without which producibility is worthless.

* Discussion "Need for Improved Performance," part of panel discussion on "Basic Problems of Producibility," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 6, 1949. (Complete panel, of which this discussion is a part, is available in multilithographed form from SAE Special Publications Department. Price: 75¢ to members, $1.50 to nonmembers.)

"What is the relationship between obsolescence and producibility?"

A related question would seem to be, "At what point in obsolescence do you change your production line to tool up for a new model?"

In peacetime, that point has almost always been overshot by the major manufacturers. From the days of the Curtiss Hawk and down through Boeing fighters and, possibly even in the cases of a jet or two, the manufacturers having the volume business have kept lines going long enough to permit less prosperous competitors, who were unhampered by existing tooling, to slip in new and winning designs. That has not given us any producibility to speak of, but it certainly has given us improved performance, and I wouldn't change the cycle for anything.

In wartime, and immediately preceding the hostilities, we took care of the obsolescence of current types insofar as possible without affecting producibility, by the use of so-called modification centers. The basic airplanes continued to roll off the lines, and the rapidly changing equipment and the myriad service-demanded changes were installed at such centers. (Here, those of you who were beset by the demands for changes in primary production will have to give me a little license).

At some point, though, you just couldn't keep a model in production, and the basic line had to be revised. I suppose that a close analysis would indicate that "producibility" is not attained until volumes of airplanes are leaving the ground on service missions having a good chance of success. If this be accepted, then the produced airplane is the sum of national effort spent in its production, and effort in a modification center must be added to that of the prime and component plants.

Neglecting pilot morale and military effectiveness as factors, it might be that obsolescence should dictate a change in production and consequently a set-back in producibility whenever the sum total of national effort in the various plants and centers becomes greater than that required by the projected new model. This, of course, could never be realized because the factors which really would govern would be those which I said we would neglect, pilot morale and military effectiveness.

Producibility is essential and is to be striven for, but producibility can become a drain on the national potential simply by using up manpower and material if the product does not give the individual warrior a better-than-even chance for success in his immediate mission.

HOW HYDRAULICS

EARTHMOVING

Fig. 1—Blade of this and many current bulldozers is hydraulically controlled

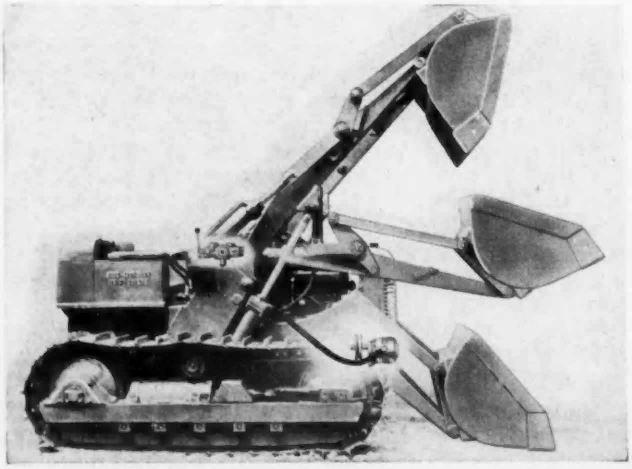


Fig. 2—Bucket of this tractor shovel is raised and lowered by double-acting hydraulic cylinders. The fine control afforded by the hydraulic system reduces operator fatigue

HYDRAULIC power is pushing earthmoving machine progress along at a rapid pace. This is exemplified by the jobs being handled by hydraulic systems on bulldozers, tractor shovels, scrapers, loaders and graders, and several special earthmoving machines.

Bulldozers, such as the one in Fig. 1, currently follow a fairly uniform pattern as regards hydraulic blade control. Hydraulic equipment on a bulldozer generally consists of two double-acting cylinders, one on each side of the tractor; a control valve with RAISE, HOLD, LOWER, and FLOAT positions; and a front-mounted pump.

The control valve in the system is the important component. At their inception, hydraulic dozers were at a disadvantage because operators expected the blade to drop as rapidly as that on a cable dozer. If the valve were so made, chances are that a void would be created in the lowering end of the cylinder. Reason for the void is the inability of the pump to supply oil to the lowering end of the cylinder as fast as the volume of the lowering end of the cylinder was increasing.

Today control valves are available that allow the blade to drop quickly and immediate down pressure can be applied to the blade without hesitation. The hydraulic bulldozer today has all the advantages of the cable unit plus the added down-pressure feature.

The FLOAT position in the control valve is practically a must for general bulldozing work. The machine must have the ability to spread earth or material while backing on and over the earth.

Fine throttling in the control valve greatly aids the operator. He can continually actuate the control valve lever to keep adjusting blade height over the terrain, which gives him a "feel" for the job he has to do.

Hydraulic shovel systems, for tractor shovels such as the one in Fig. 2, closely resemble those on bulldozers. Two double-acting cylinders, one on each side of the tractor, actuate the shovel arms for raising and lowering the bucket. Here also the control valve for these cylinders has a RAISE, HOLD, LOWER, and FLOAT position. Another pair of double-acting cylinders is used for closing and dumping the bucket.

The hydraulic-actuated bucket is the chief advantage the hydraulic shovel has over the mechanial

POWERS MACHINES

BASED ON PAPER* BY

E. J. Hrdlicka

Vice President
Hydraulic Equipment Co.

Fig. 3—Hydraulic installations for such large scrapers are now feasible both from a cost and performance standpoint

shovel. The material in the hydraulically-controlled bucket can be released into the wagon or truck at the operator's discretion.

The first bucket load dropped into an empty hauling unit can cause considerable damage and increase maintenance of the conveying vehicle if the load is dumped without exercising care. Hydraulically-controlled bucket dumping has the throttle and "feel" for soft dumping. Mechanical dumps do not have this fine bucket control. Additionally, hydraulically-controlled tractor-mounted shovels considerably decrease operator fatigue.

Hydraulic systems for shovels pose more problems than bulldozer systems, primarily because of the generally greater volume of oil. Besides the addition of bucket dump cylinders, strokes on shovel lift cylinders are about twice that of bulldozer cylinders.

Lowering dozer shovel buckets from their extreme raise positions in seconds requires movement of a large quantity of oil. Maintaining control of this quantity of oil is the task of the control valve. Basic features of the bulldozer valve operation fit this problem.

Hydraulics Applied to Scrapers

Today there are few large hydraulic scrapers being manufactured because the winch-and-cable controlled scrapers have performed better and given more trouble-free service. But this difference in performance is disappearing.

Hydraulic installations on scrapers work under more adverse conditions than bulldozers and shovels. The hydraulic equipment needed to do the job for which large cable scrapers were called upon had to be large; with this characteristic it never responded to control as quickly as the cable units. Large diameter cylinders, a large volume pump, with a control valve sufficiently large to handle the quantity of oil complicated installations and were expensive.

* Paper "Hydraulic Power as Applied to Earthmoving Equipment," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 13, 1949. (This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fig. 4—It took little modification of the hydraulic system of this grader to provide hydraulic control of the loader attachment

But now it is possible to couple pumps directly to engines with speeds up to 2000 rpm, to reduce cylinders diameters and stay within 1000 psi pressure range, and to provide hydraulic scraper performance on a par with winch-and-cable controlled scrapers. Cost of this hydraulic power allows manufacturers of large scrapers to reconsider hydraulics for their equipment.

The hydraulic scraper shown in Fig. 3 has the bowl, apron, and the bowl dumping operations handled with single acting cylinders. Single acting cylinders are possible in this application because weight of the bowl and apron can move in the lowering float position. Positive direct-connected springs return the bowl dump cylinder. Following through with an all single acting system eliminates much piping, hose, and fittings, with the possible leaks they invite. And single acting cylinder construction and valving costs less than double acting cylinders and controls.

There seems to be a definite trend toward large scrapers with hydraulic installations.

Hydraulic power also is proving useful in design of graders, with particular emphasis on control of the blade. The trunnion-mounted, double acting cylinders with socket connections near the end of the blade, are subjected to great shock load pressures. These cylinders are connected to a control valve that permits the blade cylinders to operate singly or together. Main reason for the dual control of the blade cylinders is to provide for an approximately equal raise in the blade. Without this feature, the opposite end of the blade would "dig in" when one cylinder was being raised from a set level.

Restricted orifice fittings are being used to keep the lowering travel of the blade cylinders from getting away from the pump. Spongy control would result if the cylinders were not completely filled with oil during their moving cycle.

Scarifier and leaning wheel positions now are controlled by double acting cylinders in many graders.

For many years a single-purpose machine, the road grader today mounts snow plow and loader attachments. Some of the auxiliary pieces are tied right into the original hydraulic circuit on the grader by using diverting valves. Control of the loader in Fig. 4 was made by tying in the main loader cylinders and dumping cylinders into the circuit provided for scarifier and leaning wheel cylinders. Since the four loader cylinders are never used when the scarifier and leaning cylinders are being used, and vice versa, much simpler piping and reduced conversion expense ensues. Main control valve on the grader is not changed.

While operating pressures on graders are low, shock loads of 2000 psi are frequent.

Among the special pieces of earthmoving equipment which have had marked success as a good contractors' machine is the Gradall, in Fig. 5. All of its operating cycles are hydraulically controlled. Its operating principles are illustrated in Fig. 6.

The boom can extend itself from 12 to 24 ft. It can raise itself to a height of a little more than 14 ft and lower itself to a depth of 10 ft. A tool at the end of the boom is controlled through a vertical arc of 116 deg. The boom on its roller-mounted platform permits full horizontal swing of 360 deg. The boom also can be tilted 45 deg each way from the horizontal.

Main control feature of this machine hinges on the rotating platform. Problems solved by a flow regulating valve to provide satisfactory rotation were:

1. Getting easy starts and stops when the control valve plunger was actuated. Sudden starting and stopping would break the heavy chain.

2. Finding a means of keeping the chain taut so that it would engage the sprocket.

Fig. 5—The Gradall, a special piece of earthmoving equipment, is hydraulically operated

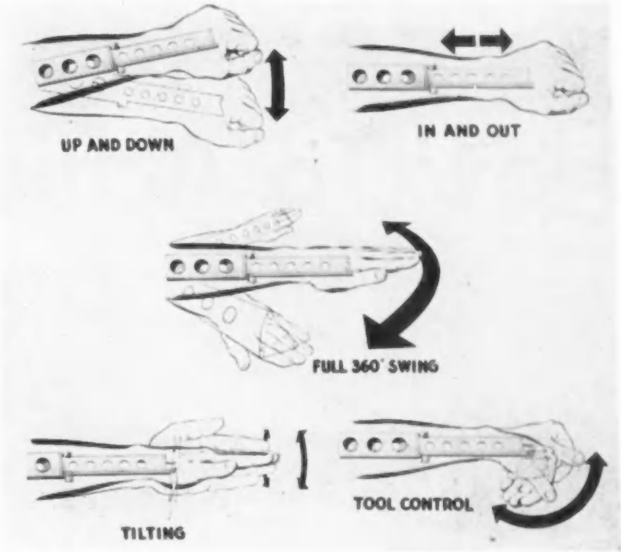


Fig. 6—Ways in which the boom of the Gradall can be operated

3. Checking the rotation travel of the boom when the unit is on a slope.

Another special earthmoving machine with an interesting hydraulic feature, its weight transferring principle, is the M-R-S tractor. Fig. 7 shows how the weight transferring works.

Let us assume a payload of 34,000 lb, which gives about 24,500 lb of weight on each wagon axle. When extra traction is needed in soft ground or on steep grades, the cylinder can transfer weight from the front wheels of the trailer to the drive wheels of the tractor by actuating the control valve. In this example, 15,400 lb have been transferred to increase the traction of the drive wheels. Smaller or larger proportions of the trailer and payload weight can be transferred by a pressure adjustment of the two relief valves in the control valve.

When the weight transfer control lever is in the neutral position, the transfer cylinder floats free and the trailer takes its front end load on its own front wheels. The cylinder does not interfere in any way with turning and leaves the wheels free to follow the ground contour. Even though the transfer cylinder is actuated by the control valve, the pressure adjustments of the relief valves allow for cylinder flotation as the ground contour requires.

Four-axle construction puts more tire surface on the ground, relieves the tractor of all load weight (except when needed for traction), and results in both on- and off-the-highway equipment.

Doors on the wagon are closed by a hydraulic cylinder carrying sheave blocks on each end. An automatic fifth wheel locking device also is adapted to the hydraulic system as auxiliary equipment for converting the wagon and tractor to a semi-unit for backing up purposes. The latter setup is used with an empty wagon and the front wagon wheels leave the ground.

The weight transfer principle is being applied to four-wheel scrapers with amazing results. Runs have been made on these weight transfer scrapers, loading themselves without a pusher rig.

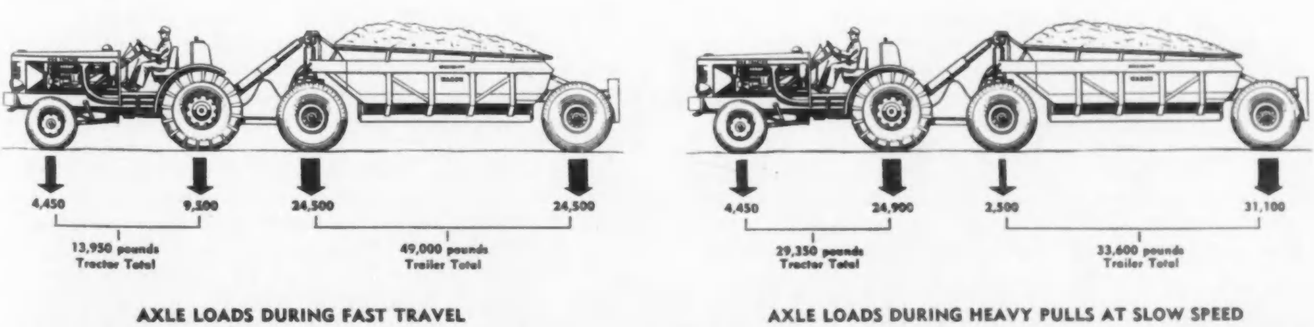


Fig. 7—An hydraulic installation is used to effect a weight transfer between the wheels of the trailer and the rear wheels of the M-R-S tractor

How To Achieve PRODUCIBILITY

Airframe Manufacturer's Ideas

EXCERPTS FROM DISCUSSION* BY **Hall L. Hibbard**
Vice-President & Chief Engineer
Lockheed Aircraft Corporation

SOME producibility gets into the design during the prototype program, but a lot does not because it cannot. Yet there is a way to work it into the design during the experimental program—if the military services pay for it.

Those considerations of producibility associated with the prototype program we shall call the *first order* of design producibility. The *second order* shall denote those considerations not ordinarily merged with prototype programs.

The first order consists of those bare essentials which are fundamentally integrated with the basic skeleton. These consist of the configuration of the airplane, the arrangement and geometrical outline of exterior components—also the structural arrangement and basic patterns of construction; the basic choice of materials; the fundamental airplane breakdown into components and the types of major joints; arrangement and space allocation for internal equipment, controls, wiring, and plumbing. These first order aspects of design cannot be altered later without necessitating new and basic design approaches.

Second order aspects of design must be confined to that which can be altered later without inducing revision of adjacent parts or assemblies; otherwise it would be of first order consideration in its effect on the basic skeleton.

Mostly, second order considerations are necessitated by those design expedients which are imposed by procurement time spans too prolonged for prototype schedules. Raw material shapes such as forgings, extrusions, permanent mold and die castings, and outsizes of sheet, plate, and bar cannot be obtained soon enough. Items such as sand castings, although usually obtainable soon enough for prototype needs, do not have full benefit of an opportunity to combine the elements of other parts, which is their greatest economic virtue.

There is little opportunity for design evolution of second order producibility—minor opportunity for simplification—in the prototype stage. A complete perspective of the design requirements in any local area does not develop until the influences of all design interests have been finalized in that area, and it is then too late for reapproachment and solution in time to suit demonstration of the prototype.

Of great significance also are those features of design, the simplification of which cannot be achieved without exploring manufacturing possibilities. For effective results it is necessary to establish the many specific applicable capabilities of facilities, techniques, and methods which proposed schemes may demand. It is necessary to determine the extent to which inplant and subcontractor competence can be stressed to take full advantage of latest developments without hazards to production schedules. These investigations and resultant evaluations, vital as they may be to producibility, are too time-consuming to demand a share of the prototype schedule, especially since their bearing on the primary purpose of the undertaking is nil.

Second order considerations define detail simplicity; the overall access in subassemblies; tooling access in fabrication; the reduction in number of parts, especially of different parts; and the multiple application of single components. Effective use of standard parts and materials is included; easy achievement of interchangeability is provided. Wise application of adjustment and take-up is necessary

Turn to page 45

* Discussion "Airframe Manufacturers' Problems and Solutions," part of panel discussion on "Basic Problems of Producibility," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 6, 1949. (Complete panel, of which this discussion is a part, is available in multilithographed form from SAE Special Publications Department. Price 75¢ to members, $1.50 to nonmembers.)

IN AIRCRAFT

Engine Manufacturer's Ideas

EXCERPTS FROM DISCUSSION* BY **E. B. Newill**
General Manager
Allison Division, GMC

ONE very simple method could be used to foster producibility. Once each year, the Air Force or the Navy should write each manufacturer a letter, saying:

"What would prevent your company from delivering the Type J-XX engine at the rate of YYY per month, 18 months from now?"

The manufacturer would then write a brief report revealing the bottlenecks he sees no way to circumvent.

Next—and this is the important step—the Service and the manufacturer would devise a program for avoiding the bottlenecks, taking into account all of the current factors.

Many will say that this suggestion oversimplifies the problem. But the method works, because that is the way that 83% of the critical material was removed from a J35 engine.

The several things which must be available in order to manufacture any product are shown in Fig. 1.

If a manufacturer receives a contract to produce quantities of jet engines at the earliest possible date, and if he is not in possession of any of the items listed in Fig. 1, which of them will delay his production longest? What interferes most with producibility?

Lack of the design of an adequate and proved product will take more time to remedy than any of the other factors. Four to six years are required from the conception of a new jet engine until it has been "wrung out" by the military services. This bottleneck can be eliminated only by programs for the design, development, manufacture, and proof in flight of continually advancing types of engines. Good producible engine designs can be made available, even if the quantities on contracts are small. Large quantities are less important than continuity of work. Thus, Producibility Enemy No. 1 is lack of a product design.

The history of the acceleration of production in World War II reveals the next most severe bottleneck: In the engine field, as in the general metal cutting industry, more time was required to obtain machinery than to be ready with people, buildings—old or new, funds, special tools, or materials. And of the machinery, the special machines obviously were the last to be ready—often by many months.

Therefore, Producibility Enemy No. 2 is found among the special machine tools.

Two steps must be taken to lick it:

1. The engine manufacturer must analyze the de-

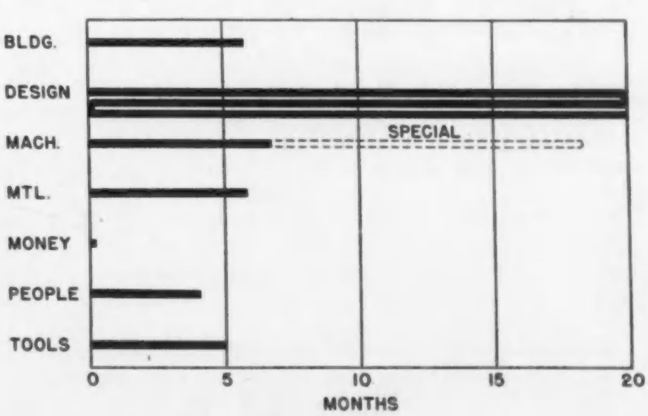


Fig. 1—Time for make ready

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sign and his methods of processing and must call for special machines in those cases where they would be required for large production. The criteria of quality, availability of skilled people, and economics should guide the selection of equipment, much as they do every day.

2. At least one of each important type of special machine should be designed, built, tooled, and proved by use in production. It is just as necessary to afford the machinery manufacturer the opportunity to perfect his design by actual use as it is for the engine manufacturer. This plan can save those precious months otherwise required for engineering work, drafting, pattern making, tooling, and "kicking in" the special machines. Recognition of this fact can accelerate production programs from three to twelve months.

Producibility Enemy No. 3 is scarcity of materials. During a war, the only really "available" materials are those in quantity production for peacetime uses. These are the only items in warehouses, in the pipelines, and in production. They are the materials which the manufacturers know exactly how to make. Use of such materials in an engine adds tremendously to its producibility. As far as practicable, materials should be employed which conform to commercial specifications, for example, the SAE series, or minor modifications thereof, such as a commercial specification to which a magnaflux inspection is added.

But there is another class of materials which approximate absolute control of the producibility of jet engines. These are rightly called the critical materials.

Many parts of jet engines operate at higher temperatures than any components of reciprocating engines, and, therefore, materials are sought which maintain good fatigue life at elevated temperatures and which resist oxidation and minimize creep. Typical parts are burner tubes, turbine wheels, turbine buckets, nozzle diaphragms, tail cones, and all parts of afterburners. Materials, including those suitable for high temperatures, which are being used but which are not available in America in adequate quantities are: columbium and cobalt, which the designer is being asked to avoid entirely; chromium, nickel, and aluminum, the use of which should be reduced as much as feasible; tungsten, beryllium, cadmium, tin, and tantalum, which should be specified only sparingly. Molybdenum, cerium, copper, zirconium, and magnesium may be used if they reduce usage of the materials mentioned earlier.

These materials are truly critical because the nation's annual supply, or even the world's annual supply, would not furnish enough of some of them to permit production of wartime quantities of jet engines of the designs which have been built to date.

Of the several types of loadings that jet engines are subject to, the most treacherous is cyclic loading, usually from parasitic forces caused by vibration of the parts. Fatigue failures result from this type of loading.

Vibration may cause fatigue failure in such parts as compressor blades, impeller vanes, air inlet guide vanes, turbine buckets, nozzle diaphragms, burner tubes, and tail cone structure. Of course, the proper remedy for this trouble, as in any mechanical device, is the elimination of the cause of the vibration, or the removal of the natural frequency of the part so far from the frequency of excitation that failure no longer occurs.

Aggravating as this problem may be, experience has demonstrated one fortunate characteristic. When the structure is first conceived, the designer usually employs the best of materials—critical materials—to assure highest strength in spite of elevated operating temperatures. However, by the time the running of the engine has taught the designer how to wipe out fatigue due to vibration, it is often possible to change to conventional material. Of course, the surface must be protected to avoid oxidation. But, if the structure is adequate when made of the fancy metals, it is likely to be satisfactory when fabricated from more common material.

An example of this principle is the inner burner liner of the J35 engine. In 1946, this part was regularly suffering distortion and severe cracking in tests lasting less than 10 hours. It was made of an alloy very high in chromium and nickel. Mechanical design of the liner was improved in successive steps with emphasis being upon elimination of hot spots through proper direction of cooling air.

As a result, it was possible to complete a standard military 150-hr type test with the liner practically as good as new. Then, using the improved design as a basis, experiments were started with a steel considered to be at the opposite pole as regards high temperature properties—namely SAE 1010 steel. Of course, a suitable oxidation-resistant coating was required with this material. Accelerated cyclic tests indicate that the SAE 1010 steel burner liner, with its surface protected, very nearly attains the life of the high alloy type.

We believe that a "lean" alloy, for example SAE 4130, suitably protected against oxidation, will achieve results in present day engines equal to those obtained with the high temperature alloys "rich" in critical materials. This work is being extended with equal success to the J33 engine inner liner.

There is the case of fatigue failure, both in England and America, of the vanes of inducers in centrifugal-flow jet engines. The inducers were made of dural forgings—the best material obtainable, a critical material. Relatively small alterations in the form of the vanes made the dural structure adequate, and now inducers of magnesium are equally satisfactory. This helps producibility in two ways. Magnesium is less critical than aluminum, and it can be machined faster, thus increasing the productive capacity of a given number of machine tools. Furthermore, the weight of the engine is reduced.

There is a configuration of the J35 engine operating satisfactorily today from which 83% of the poundage of America's six most critical materials has been eliminated. Of the columbium, 83% is gone. Cobalt is not used at all. Chromium was reduced 66%, nickel 39.5%, aluminum 96.5%, and tungsten 73%.

What happened to performance? The engine shows about 30% more thrust on the test stand than required by the specification of its predecessor, which used five times as much of the six critical materials. Its fuel consumption beats the old specification by about 5%. Durability as judged on the

test bed is not impaired, although use by the military services must give a more complete evaluation. And how much was weight sacrificed?—Well, the new engine weighs 196 lb less than the old.

The manufacturing process engineer, is striking telling blows in behalf of producibility, both by devising processes which will produce adequate parts involving less critical material and by originating methods in peace time which are all important to producibility in war time.

The story of the billet for forging the turbine wheel of the J33 engine is a credit to the process engineer. Only about half of this so-called "steel" wheel is iron, the remainder being largely critical chromium, nickel, and molybdenum. From 1945 through 1947, a large 5500-lb ingot was cast and cut into 10 billets. The metal at both top and bottom of the ingot was not good enough for turbine wheels, which rotate almost 12,000 rpm, so those portions, some 40% of the ingot, were discarded. Thus only 60% of the ingot could be used directly, and much critical material was lost in the process.

More recently, a capable and aggressive sub-subcontractor melts the various elements in a newly devised electric arc furnace and casts an individual billet for each wheel. Almost every billet can now be machined. The old billets weighed 380 lb. The new ones make a wheel for an engine delivering more thrust and weigh only 280 lb.

Ingenuity on the part of the quality control group can also add to producibility of dependable engines. In 1945, the J33 turbine wheel was inspected by X-ray. Unless a crack was over 1/16 in. across, no indication of a fault was visible through the 4-in.-thick steel forging. A method was developed to send a sound wave into one side of the billet and to "listen" for its echo from the opposite surface. Electronic devices aided in "listening." Now cleavages in the metal structure may be located even if there is no separation of surfaces; any spongy or off-standard metal structure is detected readily. Several advantages accrued. Bad wheels did not go into engines. Machine time was not wasted on forgings which later showed flaws or burst on spin test. The nature of faults could be described to the forge shop and the maker of the alloy billet, so that corrections could be devised. Producibility profited —and so did performance, dependability, and cost.

It has long been the practice in the reciprocating engine industry to control final quality by first subjecting the engine to a test known as the "contractor's run." Then the engine is dismantled rather completely, and the parts are given an inspection. If all is well, the engine is reassembled, keeping the original mating parts together, and run again on its final acceptance test. This is good practice for reciprocating engines because much can be learned following the contractor's test by an inspection of such parts as pistons, rings, valves, valve seats, cylinder walls, and bearings.

However, the inspection of a jet engine after its first test is not very revealing, as experience has proved. Duplication of testing probably will be omitted, and this recognition of the new order by quality control engineers will save millions of gallons of critical fuel, and will save manpower, reduce cost, and double the capacity of existing engine assembly departments and test stands.

Airframe Manufacturer's Ideas

Hall L. Hibbard

Cont. from p. 42

—adequate clearances and generous tolerances and economy of machining.

And this second order must consider expansibility requirements, with particular attention to the use of critical materials, so that serious bottlenecks will not be imposed if the production rate is rapidly accelerated and maintained as emergency may demand.

Some prototype programs, the results of which are highly conjectural, should be planned to include only the first order considerations of producibility— the bare essentials. For other projects, undertaken with the intention of expeditiously supplying the results in quantity, the wisdom of including both orders of producibility is apparent.

For each new type, the extent of second order producibility should be established, bearing in mind that such efforts represent investments risked on the gamble that additional contracts will ensue.

Some contractors believe that maximum producibility may be achieved during the prototype program merely by employing highly experienced designers who constantly are aware of what is best for manufacturing and thereby the resulting prototype design fully disposes all considerations of producibility. This is acceptable only insofar as the first order is concerned, wherein the configuration, arrangement, and types of construction offer little more for efficiency of manufacture than the experience and ingenuity of the designer admits. However, the second order, to be included in the prototype, necessitates a prolonged program no matter how able are its designers nor how strongly advocated are the producibility aims of the contractor.

Our solution to the problem of securing second order producibility is based on the conviction that it requires attention as soon as progress of the prototype permits. For that purpose designers, in addition to those devoted to the experimental schedules, should be assigned separately to work out the design solutions of the second order during the experimental stage. Their job: To see that all the features described earlier are specifically investigated and decisions obtained for the course to be taken in subsequent airplanes. Thereby, when production "go ahead" is authorized, the final determination of that course which should be taken to accomplish maximum producibility of the second order is already accomplished. Formal production release awaits only the completion of drafting plus the inevitable revisions which generate from flight test evaluation.

The risk may be extended to include the drafting of the production version during the experimental program. This overlap of programs, although not ideal in its efficiency, is the best compromise we have devised for trying out new ideas and yet expeditiously preparing for quantity supply of the results. It allows the advantage of not unduly restricting endeavors to try out new and radical features which distinguish progressive types.

Why haven't we in the past assigned designers separately to the solution of second order considera-

tions during prototype stages?—Because the costs involved have not been provided for in the prototype contracts, and the individual contractor could not afford to risk the hazard that future orders might not materialize.

How are we now going to engage in second order considerations during prototype stages?—We realize that our efforts on air weapons have but one purpose, that of being prepared for the defense of our country. Without the precious time that was granted in World War II, full preparedness requires a certain amount of additional expense. Producibility must be a prime consideration of each aircraft we build; else we are ignoring the main reason we are building aircraft.

We must recognize the expense of providing for coverage of producibility during prototype stages in prototype contracts. The costs, in addition to those necessary for minimum prototype development, should be adjusted in accordance with the extent of preparation for production which is deemed advisable for the particular air weapon involved.

On airplanes obviously destined for future procurement, these additional costs should include, as a minimum, provisions for full consideration of both orders of producibility in the product. They also may provide for whatever manufacturing and tooling preparation appears appropriate for the dovetailing of these interests with early production releases. Provision in prototype contracts for these activities entails the establishment or prediction of future quantities, so that amortization of tooling may bear its full significance in evaluation of alternate design schemes.

Predicted rates of production must be set forth in the prototype contract also, so that evaluations may project adequate quantities of tools, jigs, and equipment.

We cannot predict the extent producibility may reduce the price of supremacy in lives and efforts in the event of an emergency, but there is no doubt that it will be considerable. The extra cost that producibility imposes on preparedness affords an insurance that cannot be achieved in any other manner. And that cost is redeemed many times over by the dividends from efficient production.

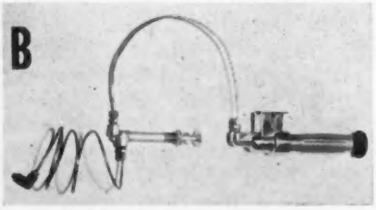
Three Ways to Inject Primer Fluid

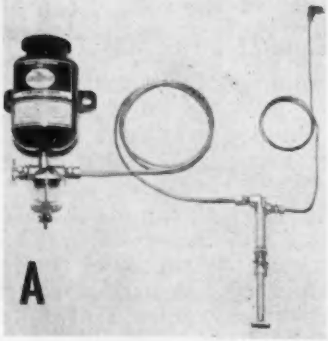
Three methods have been developed by Standard Oil Co. of Calif. for introducing an ethyl ether type priming fluid for both gasoline and diesel engines.

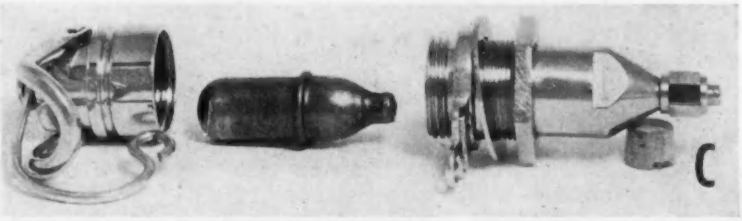
The first system, Fig. A, consists of a 1-qt steel tank, connected at its lowest point to a copper tubing leading to a hand priming gun. The fluid is pumped by the gun into the intake manifold through tubing, with an atomizing nozzle. Advantage of this system is simplicity and low cost.

In the method illustrated by Fig. B, gelatin capsules are inserted into a puncturing tool and the fluid is then pumped into the intake manifold through an atomizing nozzle. Here evaporation losses are eliminated, handling hazards reduced, and excessive dosage possibilities minimized.

The fluid also is packaged in pressurized steel bulbs, for use in the Pressure Primer system, shown in Fig. C. The bulb contains about 7.5 cc of starting fluid. The discharger consists of a hollow needle in the lower body and a closure cap with composite lever and cam-actuating mechanism at the upper end. Fluid enters the intake manifold through pressure tubing and an atomizing jet. A second bulb can be fired if necessary. (From discussion by G. L. Neely, Product Appliance Department, Standard Oil Co. of Calif., on paper "The Diesel Cold Starting Problem," by F. L. Nelson and C. J. Ulzheimer, Socony-Vacuum Laboratories.)







Selection of Steel for Automobile Parts

What Engineers Should Know Today About Hardenability-Band Steels

Part VI—Where Standard H-Bands Do Not Apply

This is the sixth of a six-part report issued by the SAE Iron & Steel Technical Committee that is appearing serially in succeeding issues of the SAE Journal. The series started in the August issue. This report was prepared at the request of the SAE Iron & Steel Technical Committee's Division XVIII, Hardenability Publications. Part I was prepared by Joseph Geschelin, Chilton Co., from material provided by the Committee's Division III, Hardenability Bands. Parts II-VI were prepared for the Division by A. L. Boegehold, Research Laboratories Division, GMC.

THERE are circumstances that make the new hardenability band specifications inadequate for meeting the requirements, as can be shown by several cases.

First let us take the case of a torsion bar spring for heavy vehicles, made from 9262 plus 0.25 molybdenum or 9262 Grainal treated.

The tempered hardness specified is 47 to 51 Rockwell C after a minimum of 850F tempering. This tempering was required to insure adequate ductility to permit a pre-setting operation. Therefore, the minimum as-quenched hardness must be at least 55 Rockwell C. Since the maximum obtainable hardness for this steel is not more than eight points higher, it is necessary only to specify a minimum hardenability to insure at least 55 Rockwell C at the center of the torsion bar.

One size used for this type of torsion bar was 2 3/16-in. diameter, so the center cooling rate when oil quenched is the same as that at a point 14/16 in. from the end of the Jominy bar. The minimum hardenability, therefore, will be represented by an H curve which passes through 55 Rockwell C at 14/16 in. from the quenched end. That is all the specification necessary, plus chemistry.

This kind of specification is permissible when there has been no hardenability band established for the steel used, as is true for 9262 plus 0.25 molybdenum or Grainal treated.

Earlier reference was made to the danger of cracking with steel in the high side of the hardenability range. In this particular example there was danger of cracking with any amount of hardenability down to the minimum required. Cracking was prevented by a time quench and a controlled time-temperature cycle prior to tempering. Prevention of cracking can usually be accomplished by proper conduct of the quenching operation, regardless of hardenability. Therefore, a maximum hardenability limit for this purpose is not a necessity unless controlled quenching is not possible.

Where it is not possible to modify the quench to stop cracking, and where high center hardness is not required, close control of hardenability is frequently effective in preventing cracking.

An example of a piece where this applied is shown in Fig. 29. This is a coupling for an oil well drilling tool tube. When made of a through-hardening steel, the coupling would crack on quenching, as shown. By selecting heats according to hardenability so that the part would harden at the surface but not at the center, cracking was eliminated. The range of hardenability required to do this, however, was much more restricted than could be obtained by ordering to the hardenability band. Selection of heats, therefore, was the only satisfactory solution to this problem.

Shell-Hardened Axle Shafts

As the subject of residual stresses becomes better understood and efforts are made to make them work for us, it will be seen that there is more and more reason for narrow hardenability limits with a definite maximum as well as minimum. This may be illustrated by the practice used by Roush[4] at Timken-Detroit Axle for making rear axles for trucks and buses.

Copies of the complete six-part series on Hardenability (SP-59) are available from Special Publications Department, Society of Automotive Engineers, 29 West 39th Street, New York 18, N. Y. Price: $1.25 per copy to SAE members, $2.50 to non-members. Quantity prices on request.

[4] Roush—Timken-Detroit Axle Co. "Information from Manufacturing Records."

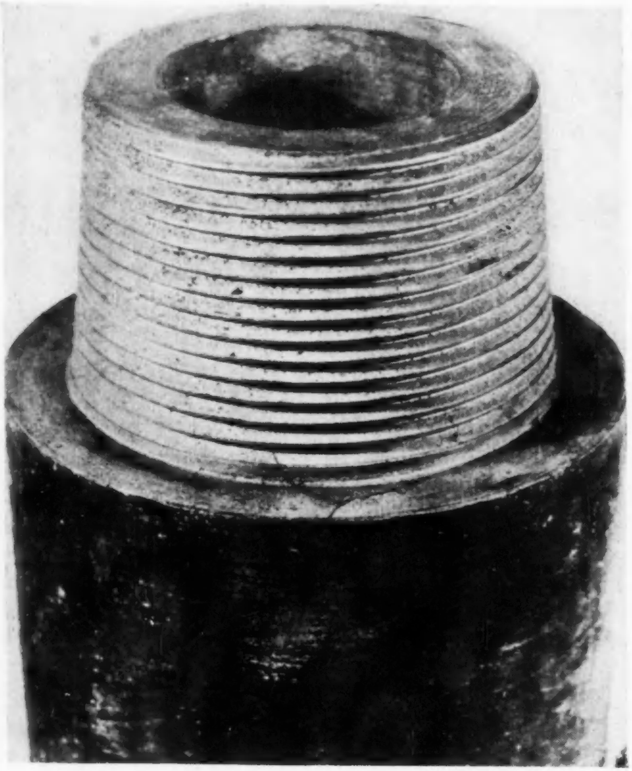


Fig. 29—As-quenched tool joint showing quenching cracks

In a certain 1 11/16-in. diameter axle shaft, the hardness limits are 55 to 60 Rockwell C at the surface and 20 to 35 Rockwell C at the center. The steel used for a period prior to the war was 1040 treated with an addition agent, and the hardenability limits that had to be maintained were 3 to 5/16 at Rockwell C 45. Since the war, 1040 and 1046 steels are used with treatment which will produce the same hardness pattern.

With a 10% caustic quench, a high surface hardness and low center hardness is obtained within the limits shown in Fig. 30.

Satisfactory shafts are obtained when hardness falls within the limits defined by the dotted lines. The desired limits are shown by the solid lines. Axle shafts made from 85 heats of 10T40 steel, made in the open hearth, all come within these solid line limits. Where several size axles are being made, control within these limits is possible by allocating each heat to the proper bar size, depending on hardenability determined on a cast bar prior to rolling. Close hardenability control is necessary in this axle because the success of the axle depends on the stress pattern left in the shaft.

When center hardness exceeds 35 Rockwell C, the shaft approaches a brittle condition so that it must be converted to a tempered shaft having a hardness of 401 to 444 Brinell. The high hardness surface layers and low hardness center result in compressive stresses at the surface which contribute to make the shaft resistant to high surface stresses from externally applied loads.

Fig. 31 shows a shaft made by this method which has been cut longitudinally to prove the presence of surface compressive stresses. The outward bending of the two cut pieces is evidence of the compressive stress at the surface and tensile stress at the center. The bending is more pronounced at one end where it will be observed from the hardness plots that the hardness penetration is greater at the point of maximum bending. As the hardness penetration increases, the compressive stress at the surface

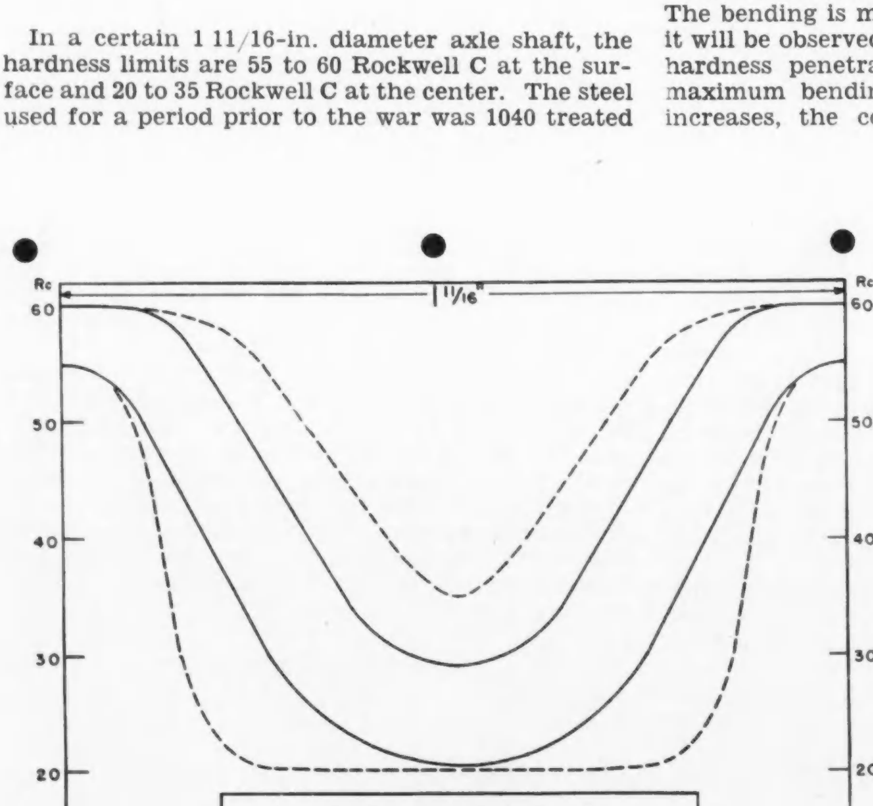


Fig. 30—Desired hardenability for shell-hardened axle shafts (O.H. 1040 Grainal-treated steel)

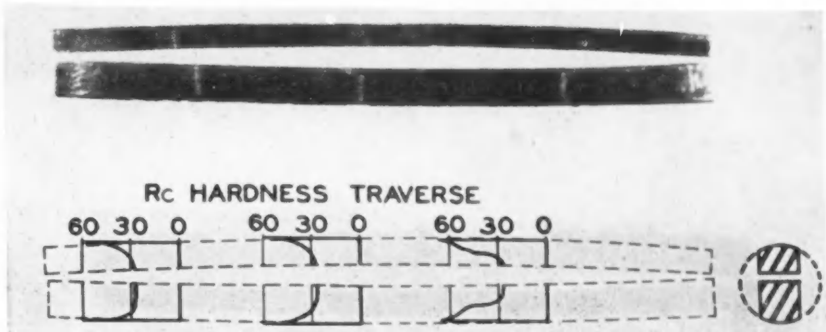


Fig. 31—Residual stress in shallow-hardening steel shaft (SAE 1045, quenched from 1550F in 5% caustic soda at 110F, tempered at 350F)

again decreases until it disappears, and when full hardening occurs at the center, the stresses at the surface may reverse and become tensile.

To illustrate this, Fig. 32 shows a 1-in. plate made from high-hardenability steel which was water-quenched and then cut to show stress distribution. Two such pieces were placed with outside surfaces together to show the concave condition at the surface. This surface concavity is proof that the surface was in tension and the center in compression. To avoid this result is good reason for requiring a maximum limit for hardenability. The advantage derived from surface compressive stresses is greatest when the part is not tempered very much because tempering reduces these stresses.

Of interest is the fatigue life of a shell-hardened shaft compared to an alloy steel shaft tempered to 401-444 Brinell. At 60,000 psi surface torsional stress:

	4340 steel	lasted	10,000	cycles
	8949 "	"	36,000	"
Shell-Hardened	10T40 "	"	500,000	"

When a shaft with high surface hardness also has high center hardness, the unfavorable trapped stresses nullify the strength and fatigue resistance which is a normal property of high-hardness steel. A shaft of this kind subjected to test, breaks in a relatively few cycles with the extremely brittle type of fracture shown in Fig. 33. The surface hardness was 56 and the center hardness was 52 Rockwell C. The high-side hardenability limit in this part, therefore, is imperative in which respect it differs from the handling of the torsion bar previously described.

Carburized Parts

Rear-axle ring gears, drive pinions, transmission gears, bearing races, and all such highly-stressed high-hardness parts can be greatly benefited by close control of hardenability. The reason for this again involves preventing the creation of unfavorable trapped stresses much more than it does the formation of certain structure and hardness per se.

The success of carburized rear axle gears depends also upon uniform shape of teeth to insure uniform load distribution along with high residual compressive stresses in the case to oppose the stresses from externally applied loads. We have seen that, to obtain favorable stresses in shell-hardened axles, it is necessary for control of hardenability within narrow limits. The same is true for carburized gears and other parts, and this same control of hardenability also will assist in achieving a uniform type of distortion from hardening which can be compensated for when cutting the gear teeth in the green.

Fig. 34 shows tooth contacts in a rear axle ring gear, illustrating an undesirable condition where the load is applied too far toward the heel of the

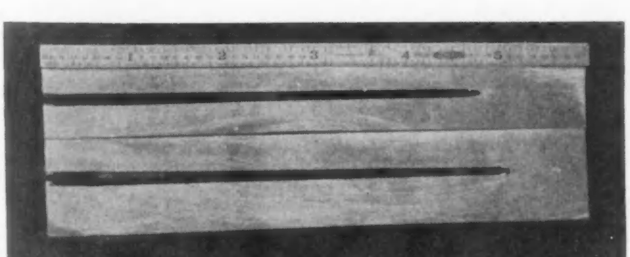


Fig. 32—Concave condition of the surface of these plates shows that surface was in tension, center in compression. These are specimens from a 1-in. plate made from high-hardenability steel which was water-quenched and then cut to show stress distribution

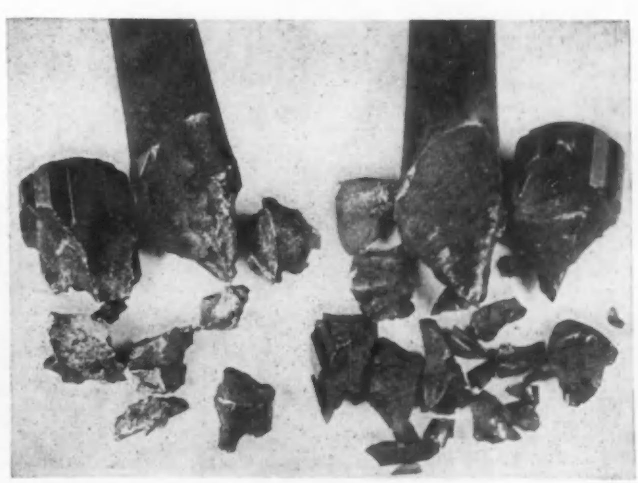
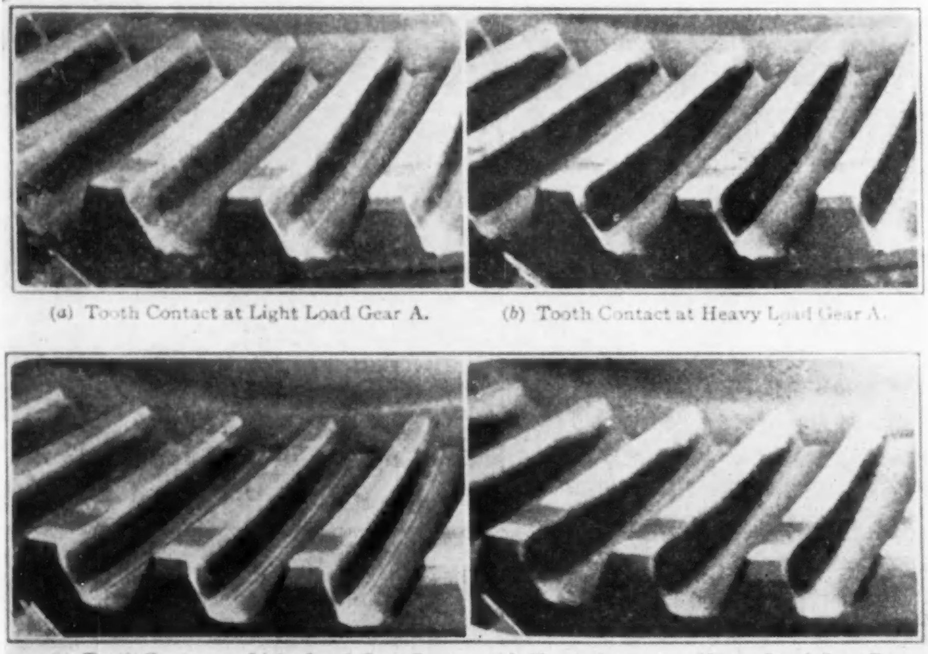


Fig. 33—The brittle type of fracture with these two shafts illustrates that high surface hardness coupled with high center hardness nullifies strength and fatigue resistance of high-hardness steel


(a) Tooth Contact at Light Load Gear A. (b) Tooth Contact at Heavy Load Gear A.

(c) Tooth Contact at Light Load Gear B. (d) Tooth Contact at Heavy Load Gear B.

Fig. 34—Gear A shows better tooth contact than Gear B

tooth when the heavy load from low gear torque is applied. Also shown is the centrally-located contact which is to be desired. Uniformity of distortion in heat treatment is desired to aid in obtaining this type of load distribution. The volume changes associated with transformation in the case and core, therefore, must be held as uniform as possible, both as to magnitude and sequence. Experience by one manufacturer has indicated that a range of 10 points Rockwell C in the core should not be exceeded for good results. Core hardnesses ranging from 25 to 35 Rockwell C at the root of the tooth are considered the outside desired limits.

In this connection it is interesting to look at the derived cross-section hardness curves for the upper and lower hardenability limits for 4620 H specification steel in Fig. 35. Only in sections bigger than 2 in. in diameter can anything like a 10-point Rockwell range be realized. In ½-in. sections, the hardness ranges from 22 to 48 Rockwell C.

As core hardness of gear teeth exceeds 40 Rockwell C, the compressive stresses desired in the case decrease and they may be replaced by tensile stresses that may build up to the point where fracture of the case occurs. Fig. 36 shows an example of a gear where this actually happened in every tooth, one of

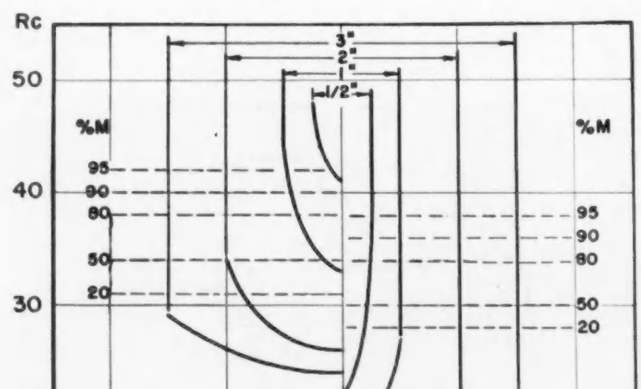


Fig. 35—Cross-section hardness curves for the upper and lower hardenability limits for oil-quenched 4620H steel

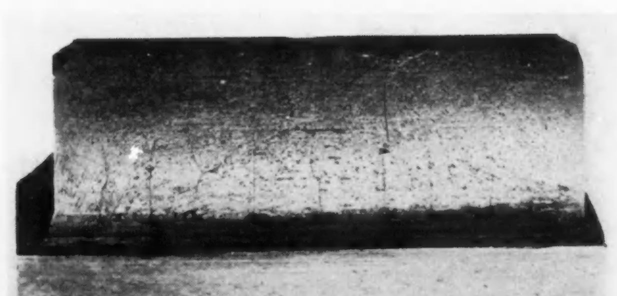


Fig. 36—The case of this tooth as well as every other one in the gear cracked because relative cross-section of the case and core were such that the core was stronger than the case

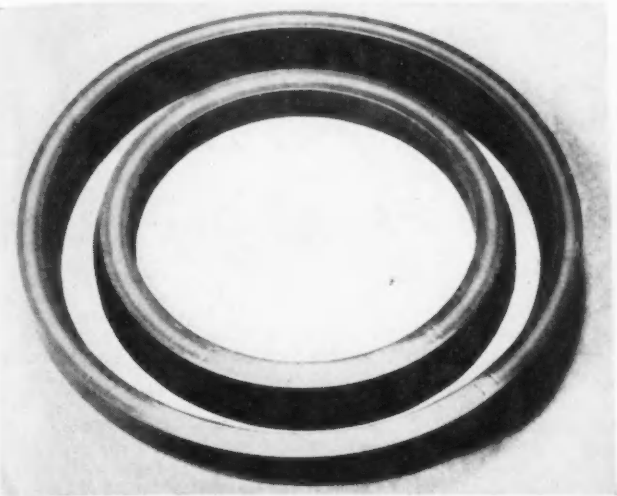


Fig. 37—Stresses imposed by the core of this roller bearing race cracked the case

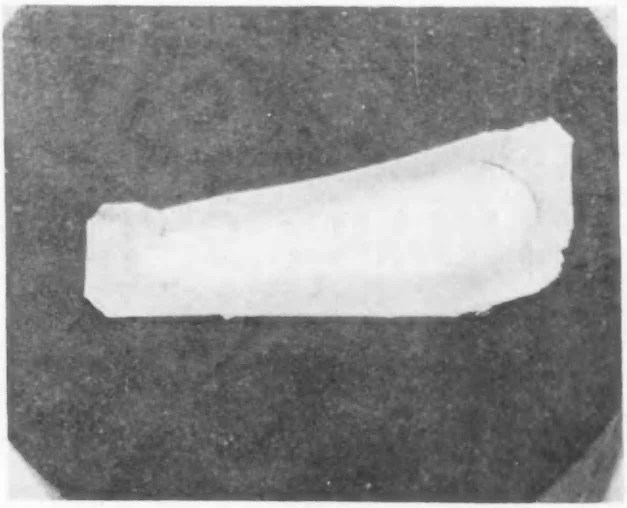


Fig. 38—Section of the race in Fig. 37 showing how case cracked away from the core

which is shown. The core hardness in this gear was 40 to 45 Rockwell C. This high core hardness is especially bad where grinding is done after hardening. In this gear, the case cracked because the relative cross-section of case and core were such that the core was stronger than the case.

However, with a high ratio of case-to-core and a thin section overall, the case is stronger. When the core expands during hardening, it will set up tensile stresses in the case; but the case will be strong enough to assume these stresses without failing, although it may stretch some. Then when the core contracts again after having transformed, it is subject to tri-axial stresses and, therefore, cracks.

Fig. 37 shows where this has happened in a roller bearing race. Here again the core hardness was over 40 Rockwell C. Fig. 38 shows another section of the same bearing race. The case has cracked away from the core in addition to the radial cracks.

To prevent cracking such as just described, or what is worse, high residual stresses on the verge of cracking, at least one plant specifies a hardenability band for rear axle gears in which the spread between high and low side hardenability is only about one-half the width of the SAE H-band for 4620 steel.

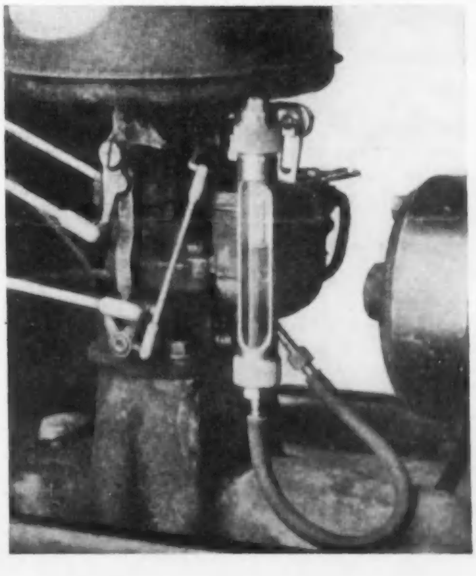
The number of heats the steel maker can put within this narrower band is in the neighborhood of 66% of those melted. You can see, therefore, that to specify that kind of limits, it is necessary either to pay more money or else to have other uses for the other 34% of heats which fall outside the narrow band. We are looking forward to the day when the steel maker can put 100% of his heats within such a band.

Gage Shows Carburetor Fuel Level

An important factor in proper engine operation and fuel economy is the gasoline level in the carburetor bowl, because this influences the action of various jets.

One way of doing this is by a sight gage, shown at right installed on the carburetor of a Ford V8. The gage is mounted on the outside of the bowl by a bracket held in place by one of the screws in the carburetor float cover. Some types have a vent so that the air blown past by the fan has no effect on the level height. Another refinement is a sliding scale on which zero can be set to the reference point for easy reading.

One end of the gage is connected into the drain plug hole. The level can be checked while the engine is running. Any variation in level, due either to excessive pump pressure or a poor needle valve, will readily be indicated. (From paper "Modern Engine Testing Equipment," by M. E. Nuttila, Cities Service Oil Co.)



SAE 1950 ANNUAL

JANUARY 9–13

Monday, Jan. 9

10:00 a.m. **M. M. ROENSCH, Chairman**

Piston Ring Design and Application and Their Effect on Wear
—A. N. BRENNEKE, Perfect Circle Corp.
Prepared Discussion
(Sponsored by Diesel Engine Activity)

10:00 a.m. **R. E. GEROR, Chairman**

Some Tricks in Cold Weather Operation
—J. T. DYMENT, Trans-Canada Air Lines

Operational Results of Thermal Anti-Icing
—M. G. BEARD and D. NORTH, American Airlines, Inc.
(Sponsored by Air Transport Activity)

2:00 p.m. **A. H. FOX, Chairman**

Business Session of Diesel Engine Activity

The New Caterpillar Supercharged Diesel Engine
—J. H. GILL and R. S. FRANK, Caterpillar Tractor Co.
Prepared Discussion
(Sponsored by Diesel Engine Activity)

2:00 p.m. **P. E. HOVGARD, Chairman**

Fatigue Life of Aircraft Engine Mounting Components
—R. C. HENSHAW, LEON WALLERSTEIN, JR., and S. J. ZAND, Lord Manufacturing Co.

The Effect of Environment on Design Criteria of Helicopter Transmissions
—DIETRICH W. BOTSTIBER, Piasecki Helicopter Corp.
(Sponsored by Aircraft Activity)

8:00 p.m. **E. W. CONLON, Chairman**

Business Session of Air Transport Activity

Opportunities for Aeronautical Engineers in Air Transportation
—E. H. BARKER, Parks College of Aeronautical Technology

The Avro C-102 Jetliner
—J. C. FLOYD, A. V. Roe Canada Ltd.
(Sponsored by Air Transport Activity)

Tuesday, Jan. 10

9:30 a.m. **H. L. MOIR, Chairman**

Symopisum on Combustion of Fuels

Some Fundamental Aspects of the Measurement of Detonation
—D. R. deBOISBLANC, Phillips Petroleum Co.

The Ignition of Fuels by Rapid Compression
—C. F. TAYLOR, E. S. TAYLOR, J. C. LIVENGOOD, W. A. RUSSELL and W. A. LEARY, Massachusetts Institute of Technology

Precombustion Reaction in the Spark Ignition Engine
—MINOR C. K. JONES and EDMOND RETAILLIAU, Esso Laboratories, Standard Oil Development Co.

A Study of Mixture Distribution in a Modern Multi-Cylinder Engine
—R. W. DONAHUE and R. H. KENT, JR., Sun Oil Co.
(Sponsored by Fuels and Lubricants Activity)

9:30 a.m. **H. D. HOEKSTRA, Chairman**

Business Session of Aircraft Activity

Developments in the Use of Airplanes and Helicopters for Dusting, Spraying and Seeding
—Airplanes—HOWARD HASBROOK, Aero International Co.
—Helicopters — CHARLES KIRCHNER, JR., The Kaman Aircraft Corp.
—Airplane Spray and Dust Application—O. K. HEDDEN and D. A. ISLER, U. S. Department of Agriculture
(Sponsored by Aircraft Activity)

2:00 p.m. **A. O. WILLEY, Chairman**

Business Session of Fuels and Lubricants Activity

150 Miles Per Gallon Is Possible
—R. J. GREENSHIELDS, Shell Oil Co.

The Performance of High Viscosity Index Motor Oils
—C. L. FLEMING, JR., B. W. GEDDES, N. V. HAKALA and C. W. WEISEL, Esso Laboratories, Standard Oil Development Co.
(Sponsored by Fuels and Lubricants Activity)

2:00 p.m. **L. A. GILMER, Chairman**

Business Session of Tractor and Farm Machinery Activity

Motion Picture: Soil—Vehicle Mobility Relationship
Presented by P. W. WOODRING, through the courtesy of Engineer Research & Development Labs., U. S. Corps of Engineers, Fort Belvoir

Relationship Between Soil and a Vehicle
—MAJOR M. G. BEKKER, Department of National Defence, Canada
(Sponsored by Tractor and Farm Machinery Activity)

8:00 p.m. **BUSINESS SESSION**

President S. W. Sparrow in the Chair

Nomination and Election of Members-at-large of Annual Nominating Committee
Announcement of Election of Officers for 1950
Presentation of the President's Report
Presentation of Life Membership

8:15 p.m. **L. C. GOAD, Chairman**

Business Session of Production Activity

Process Development—The Link Between Engineering and Manufacturing
—R. J. EMMERT, General Motors Corp.
(Sponsored by Production Activity)

Wednesday, Jan. 11

9:30 a.m. **G. A. DELANEY, Chairman**

The Studebaker Automatic Transmission
—H. E. CHURCHILL, Studebaker Corp.

The Chevrolet Automatic Transmission
—R. S. PLEXICO and R. E. KAUFMAN, Chevrolet Motor Division, General Motors Corp.
(Sponsored by Passenger Car Activity)

MEETING

Book-Cadillac Hotel, Detroit

DINNER 6:30 p.m.
Wednesday, Jan. 11
DETROIT MASONIC TEMPLE

Speaking Program—8:00 p.m.
A. C. HAZARD, Chairman, SAE Detroit Section
Master of Ceremonies—
ROBERT L. BIGGERS, President, Fargo Division, Chrysler Corp.
S. W. SPARROW, 1949 President SAE
JAMES C. ZEDER, 1950 President SAE

Principal Speaker
GENERAL J. LAWTON COLLINS
Chief of Staff—U. S. Army
General Motors Chorus

9:30 a.m. ROBERT INSLEY, Chairman

High Altitude Aircraft Oil Systems
—F. E. CARROLL, JR., Air Materiel Command

Driving Aircraft Accessories Remotely from the Aircraft Engine
—H. R. SHOWS, Air Materiel Command

Heat Requirements for Ice Prevention on Gas-Heated Propellers
—V. H. GRAY, National Advisory Committee for Aeronautics
(Sponsored by Aircraft Powerplant Activity)

2:00 p.m. S. W. SPARROW, Chairman

Business Session of Passenger Car Activity

Presentation of HORNING MEMORIAL MEDAL to T. A. BOYD by A. J. BLACKWOOD, chairman, Horning Memorial Board of Award. Medal to be awarded by Mrs. ELSIE M. HORNING, Sponsor.

Pathfinding in Fuels and Engines—Horning Memorial Lecture
—T. A. BOYD, Research Laboratories Division, General Motors Corp.

(Sponsored by Passenger Car Activity)

2:00 p.m. A. L. BEALL, Chairman

Business Session of Aircraft Powerplant Activity

Ground and Flight Evaluation Installations and Some of the Performance of Jet Powerplant Installation Factors Affecting Output
—WILLIAM WAHL and M. A. SULKIN, North American Aviation, Inc.

Designing Turboprop Controls
G. P. KNAPP, Propeller Division, Curtiss-Wright Corp.
(Sponsored by Aircraft Powerplant Activity)

Thursday, Jan. 12

9:30 a.m. J. L. S. SNEAD, JR., Chairman

Brakes, and Brake Lining Characteristics
—J. G. OETZEL, Warner Electric Brake Manufacturing Co.
Prepared Discussion

(Sponsored by Transportation and Maintenance Activity)

9:30 a.m. W. P. EDDY, JR., Chairman

Review of NACA Research on Materials for Gas Turbine Blades
—G. M. AULT and G. C. DEUTSCH, National Advisory Committee for Aeronautics

Reduction in the Use of Strategic Materials in Turbojets
—J. M. PEDERSON, General Electric Co.
(Sponsored by Aircraft Powerplant Activity)

2:00 p.m. PHILLIP ROTHWELL, Chairman

Panel Discusion—Functional Approach to Body Design
—Moderator—ERIC LANGE, Fisher Body Division, General Motors Corp.

Panel Members
—JOHN NAJJAR, Ford Motor Co.
—L. L. ANDERSON, Chrysler Corp.
—H. R. PACIFIC, Ford Motor Co.
—G. P. GAULIEN, Fisher body Division, General Motors Corp.
(Sponsored by Body Activity and Detroit Section Junior Activity)

2:00 p.m. M. E. NUTTILA, Chairman

Business Session of Transportation and Maintenance Activity

Better Exhaust Systems for Trucks and Buses
—E. E. BRYANT, Nelson Muffler Corp.
(Sponsored by Transportation and Maintenance Activity)

8:00 p.m. R. A. TERRY, Chairman

Business Session of Body Activity

Body Styling Today
—RAYMOND LOEWY, Raymond Loewy Associates
(Sponsored by Body Activity)

Friday, Jan. 13

9:30 a.m. J. S. LAIRD, Chairman

Gaskets as Engineering Materials
—J. P. WILSON, Ford Motor Co.

Fibre Board Products Used in Automotive Production
—J. W. GREIG, Woodall Industries, Inc.

Automotive Brake Lining Materials
—A. J. CARTER, Chrysler Corp.
(Sponsored by Engineering Materials Activity)

9:30 a.m. LESTER BELTZ, Chairman

Air Conditioning of Automotive Vehicles
—A. T. BROWNE, ACF-Brill Motors Co.

Full Vacuum Controlled Ignition System
—C. W. RAINEY, Ford Motor Co.
Prepared Discussion
(Sponsored by Truck and Bus Activity)

2:00 p.m. R. W. ROUSH, Chairman

Business Session of Engineering Materials Activity

Brake Drum Materials
—F. J. WALLS, International Nickel Co., Inc.

Nodular Cast Iron
—GOSTA VENNERHOLM, Ford Motor Co.
(Sponsored by Engineering Materials Activity)

2:00 p.m. HOY STEVENS, Chairman

Business Session of Truck and Bus Activity

A Method of Predicting Road Performance of Commercial Vehicles
—A. F. STAMM and E. P. LAMB, Chrysler Corp.
Prepared Discussion
(Sponsored by Truck and Bus Activity)

Induction Hardening

Gear Tests and Performance . . .

EXCERPTS FROM PAPER BY **H. B. Knowlton** Supervisor of Materials Engineering International Harvester Co.

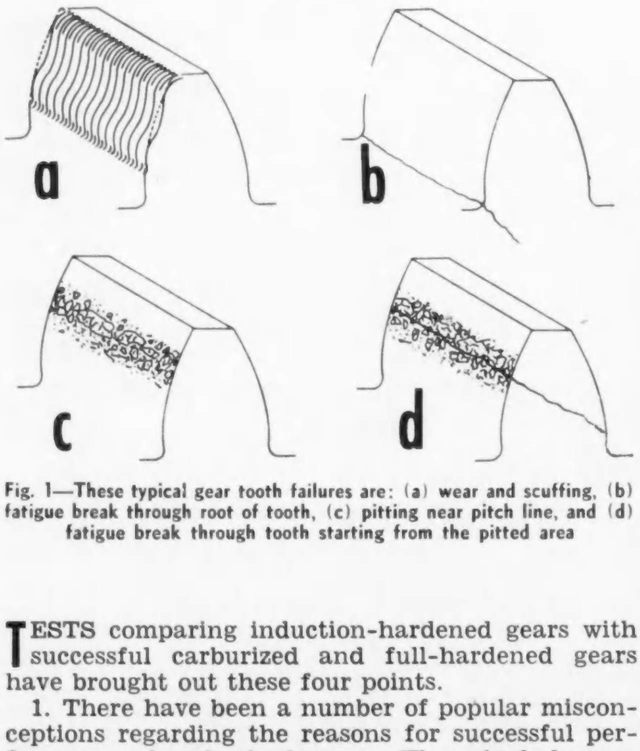


Fig. 1—These typical gear tooth failures are: (a) wear and scuffing, (b) fatigue break through root of tooth, (c) pitting near pitch line, and (d) fatigue break through tooth starting from the pitted area

TESTS comparing induction-hardened gears with successful carburized and full-hardened gears have brought out these four points.

1. There have been a number of popular misconceptions regarding the reasons for successful performance of carburized gears. These include contour hardening of the case and certain physical properties of the core.

2. It is not necessary that induction-hardened gears should be made of the same steels, or duplicate the hardening pattern of carburized gears to perform successfully.

3. Satisfactory induction hardened gears may be made by different methods provided the fatigue strength, toughness, and residual stresses are compatible with the magnitude and type of stresses to be encountered in service.

4. Unsatisfactory gears may result if any of the first three points are not considered.

For a better understanding of factors making for successful gears, let us first mention the types of failure observed in the past, as shown in Fig. 1.

True wear consists in removal of metal from the surface. This may take the form of smooth wear producing a polished surface, or a very rough wear producing a scored or scuffed surface. Resistance to smooth wear seems to be proportional to hardness and carbon content of the steel, and to some other factors, including machining finish and lubrication.

Scuffing is due to a metal-to-metal seizure. This is not common with tractor gears, but frequently occurs with high-speed heavy-duty hypoid pinions. Heavy pressure and high rubbing velocities tend to break the oil film and produce metal seizure. The usual correction is a pretreatment to produce a phosphate coating on the gear, or the use of extreme pressure lubricants in service.

The second type of failure, breakage at the root, is a bending fatigue failure usually starting in the fillet at the surface.

Pitting at the pitch line is a crushing fatigue type of failure probably starting as a shear failure beneath the surface. Case depth and core hardness of carburized gears are factors in the production of this type of failure. Pitting frequently starts after several million cycles of operation.

Pitting and breakage from the pitch line, the

* Papers "Induction Hardened Gears," by H. B. Knowlton and H. F. Kincaid and "High Frequency Heat-Treatment of Gears—Equipment and Processes," by J. A. Redmond, were presented at SAE National Tractor Meeting, Milwaukee, Sept. 14, 1949. Both papers will be printed in full in SAE Quarterly Transactions. (Each paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ each to members, 50¢ each to nonmembers.)

# of Gears*

Hardening the surface of gear teeth through high-frequency induction heating holds both engineering and production advantages over carburizing, Knowlton, Kincaid, and Redmond show in this article.

Knowlton uses engineering test and service performance data to explain the difference in load-carrying capacity between induction-hardened and carburized gears. He also discusses factors that make for successful induction-hardened gears.

Type of equipment and methods for induction hardening gears used by International Harvester are described on pp. 58-60 by Kincaid. Redmond details the power requirements of the process and shows the effect of difference in heating values on pp. 60-62.

fourth kind of failure shown in Fig. 1, rarely occurs in field operation of tractor gears. We have seen tractor bull gears which appeared badly pitted after seven years use, but were still giving satisfactory service. On the other hand, pitting is a potential cause of failure, if the gear receives a sufficient number of cycles at high stress after pitting starts.

In one laboratory test, a bull gear tooth broke from the pitted area at the pitch line after 1000 hr on the dynamometer under severe overload conditions. No field failures of this type were ever reported with this gear.

Many tests have been run to determine the resistance to pitting. In general, the effort has been made to determine that a prohibitive amount of pitting will not occur during the expected life of the gears. It has been found that pitting may start after more than 20,000,000 cycles of operation. However, large final drive gears which do not receive 20,000,000 cycles of maximum stress in their entire life should probably not be required to withstand 100% maximum stress for that length of time. A definite relationship has been found between cleanliness of steel and resistance to pitting.

Chipping of corners of clash teeth is another type of failure which may or may not destroy the usefulness of the gear. (See Fig. 2.) Probably many tractor gears in service have chipped to some extent on the clashing points. It seems probable that the exact mechanism of this type of failure has not yet been determined. While undoubtedly hardness and structure are factors, failures are not due entirely to the presence of "excess" cementite. The design of the tooth rounding is probably more important than metallurgical structure.

Many misconceptions exist concerning the properties which make carburized and/or hardened gears fail in these ways or make them successful in service. For example, a frequent assumption has it that core hardness is the most essential property of carburized and hardened gears.

An attempt to plot the results of a large number of dynamometer tests in terms of fatigue strength versus core hardness showed no correlation between core hardness and dynamometer performance.

Both good and poor performance were found with

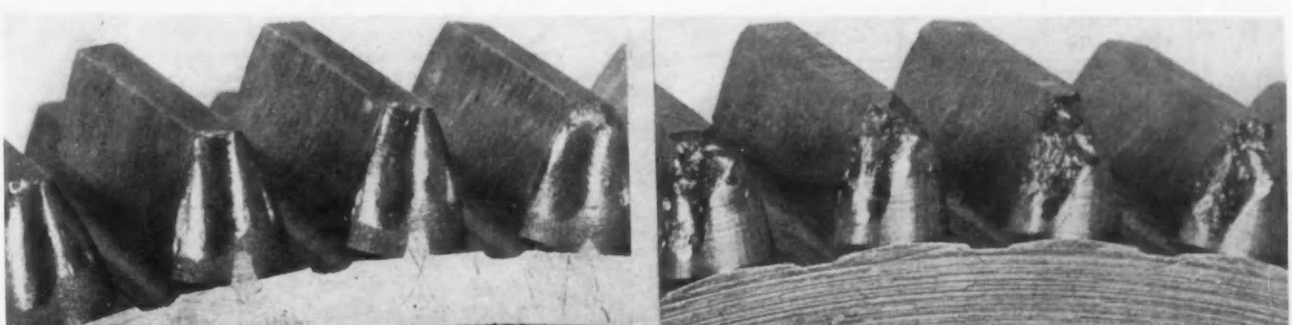


Fig. 2—In clash tests the gear teeth at left were shown to have good form; those at right, poor tooth form ←

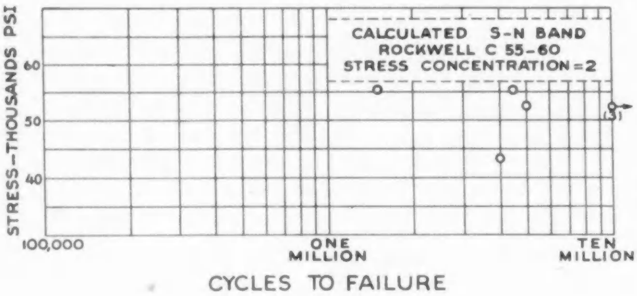


Fig. 3—Bending fatigue strength of 7-pitch induction-hardened gears

a hardness of 19 Rockwell, and similarly good and poor figures were obtained at 39 Rockwell. It has since been found that some carburized and hardened gears having a core hardness of 48 are extremely brittle, while others made of the same steel, and hardened for the same identical hardness, are extremely tough. This difference was produced by changing the speed of quenching, which undoubtedly had an effect upon the residual stresses set up in the gear.

Core hardness in itself does not determine the merit of the carburized and hardened gear. Similarly case depth in itself is not a safe criterion for predicting the properties of the carburized and hardened gear. It is true that a certain minimum depth of case is usually necessary to support load and prevent pitting at the pitch line, and also to prevent rupture between the case and the core. The minimum case depth necessary is affected by the hardness of the core.

The following factors are all involved in the bending fatigue strength of carburized and hardened gears:

1. Hardness and strength of carburized and hardened gears,
2. Structure and toughness of the case,
3. Depth of case, and
4. Residual stresses set up by quenching.

Too much emphasis cannot be placed upon the function of residual stresses which may either add to, or detract from, the inherent strength of carburized and hardened teeth. It is often said that carburized and hardened gears are under compressive stress at the surface. But this is not necessarily

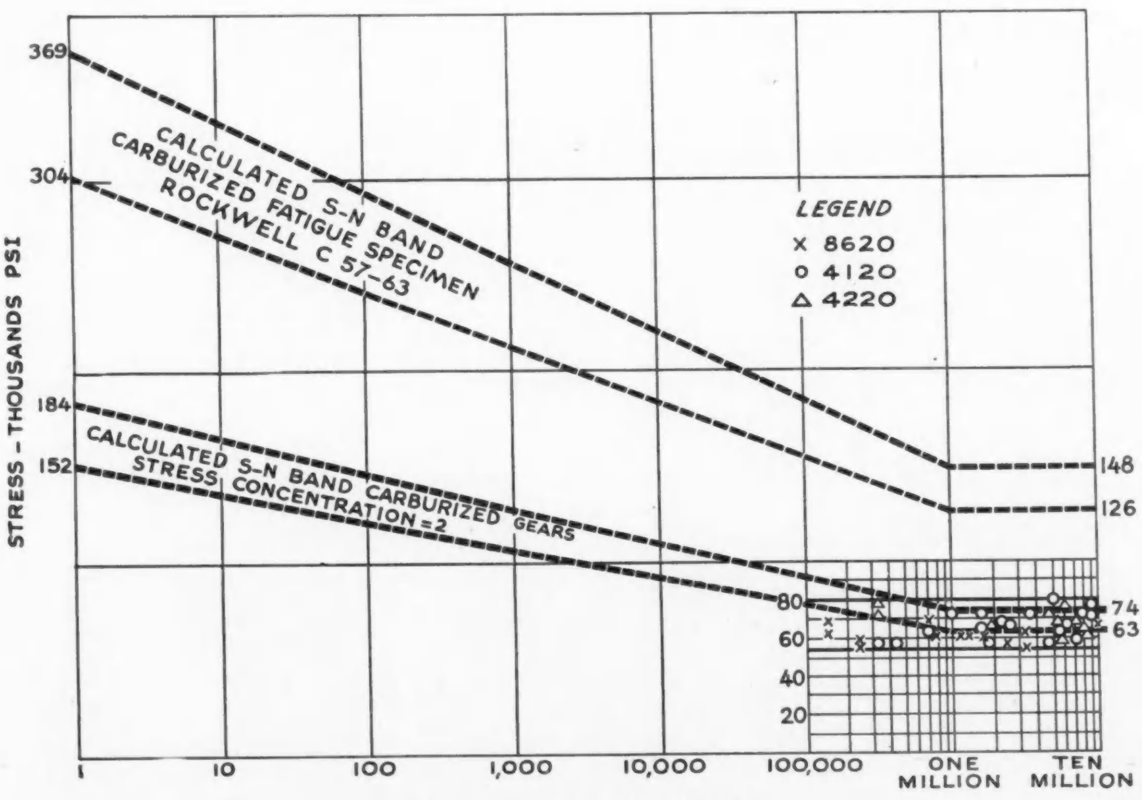


Fig. 4—Bending fatigue strength of 7-pitch carburized gears

true. Stresses are not produced by carburizing, but by subsequent quenching operations. The type of quench and the time and temperature of tempering, or drawing, are responsible for different types and degrees of residual stress.

Generally, steel contracts as it cools except when it passes through a phase change, such as occurs during hardening. This is accompanied by a dilation or expansion. If the core of a gear tooth hardens after the surface has become hard, it will expand and set up tensile stresses in the surface.

On the other hand, if the analysis of the steel, or the speed of quenching is such that the core does not harden, the tensile stresses at the surface will not be produced. In fact, as a general rule a soft core may be associated with compressive stresses at the surface.

This is probably the reason it is so often assumed that a soft tough core is necessary in gears. Actually when a gear tooth bends in service the greatest deformation must occur in the surface, not in the center. For this reason the toughness of the surface, not the toughness of the core, governs the toughness or brittleness of the gear tooth.

Induction-Hardened Gears

It becomes apparent that to produce satisfactory properties in induction hardened gears, it is not necessary to produce a hard case following the exact contour of the tooth surface, nor to produce a soft core. It is necessary to produce a hard layer around the entire surface of the tooth including the fillet. This layer must be of sufficient depth to support crushing loads, and to assure that the outer portion of the core is not near enough to the surface to be in a zone of high bending stresses. But the residual stresses must be carefully controlled. The stresses at the surface preferably should be in compression or be near zero. In some cases high compressive stresses at the surface may be associated with a prohibitive degree of tensile stress at some other location.

Fig. 3 shows the results of dynamometer tests of special 7-pitch induction-hardened gears. These gears are identical in design with carburized gears, for which test results are shown in Fig. 4. It will be noted that the bending stresses causing failure in these gears varied from 43,000 to 55,000 psi. The minimum Rockwell hardness is 55 Rockwell C instead of 57 for the carburized and hardened gears.

It would be expected that the bending strength would be somewhat lower. The actual observed figures, howver, are slightly lower than would be calculated from the conversion of hardness to strength. This leads to the assumption that the residual stresses in these particular gears may not be quite as favorable as those in the carburized gears. If this is true, it is quite probable that improvements in the heat-treating practices for these gears may raise their bending strength.

So far the discussion has been limited to one specific gear, which is a standard test gear. Results have been stated in terms of bending stresses calculated by conventional formulas. It will be noted that the fatigue strength, or load-carrying capacity of the carburized and hardened gears is apparently slightly higher than that of the induction-hardened gears. This comparison, however,

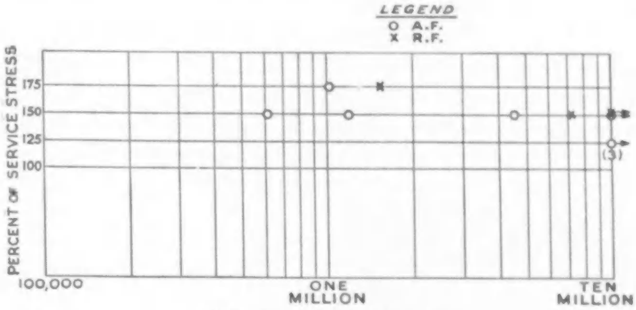


Fig. 5—Bending fatigue strength versus service stress of RF (radio frequency) and AF (audio frequency) induction-hardened 7-pitch gears

does not hold for all types of gears. Sometimes the induction-hardened gears carry higher loads than similar carburized and hardened gears.

Remember that stress calculations are based on the assumption that the load is distributed evenly over the full width of the gear tooth. If the gear distorts in hardening, this will not be true. The actual stress therefore depends upon the degree of distortion which occurs in heat treating. For this reason induction-hardened gears which suffer very little distortion may carry higher loads than carburized gears, which show a greater amount of distortion.

In this connection it should be emphasized that every gear presents a problem of its own. The stresses calculated by conventional formulas vary slightly with the design of the gear. The machining finish plays an important part. Details of the induction hardening process must be varied so as to produce satisfactory properties for the individual gear concerned.

Real criterion for a satisfactory gear is that it must have sufficient strength to withstand the stresses it will encounter in service.

For this reason engineering tests have been performed to determine whether the gears are capable of withstanding service stresses rather than determining whether they meet some arbitrary figure for

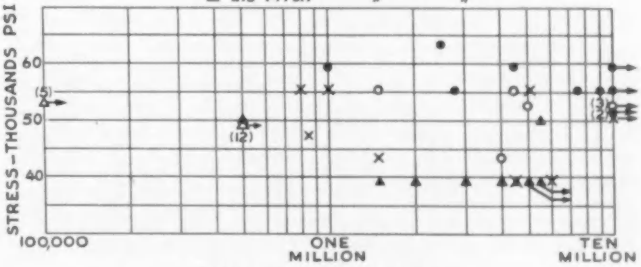


Fig. 6—Bending fatigue strength of induction-hardened gears from 2.5 to 8-pitch

strength, or are stronger or weaker than carburized gears. A study of the fatigue bands for both carburized and hardened, and induction-hardened gears, shown in Figs. 3 and 4, indicates a variation of about 25% in the fatigue strength of any one type of gear. Therefore, if gears satisfactorily withstood a stress of 125% of the maximum possible service stress, the gears should be satisfactory.

It seems unlikely that the maximum service stress will be encountered for a great many cycles of operation. However, for safety's sake it was decided to require that gears should withstand 125% of the calculated service stress for 5,000,000 cycles.

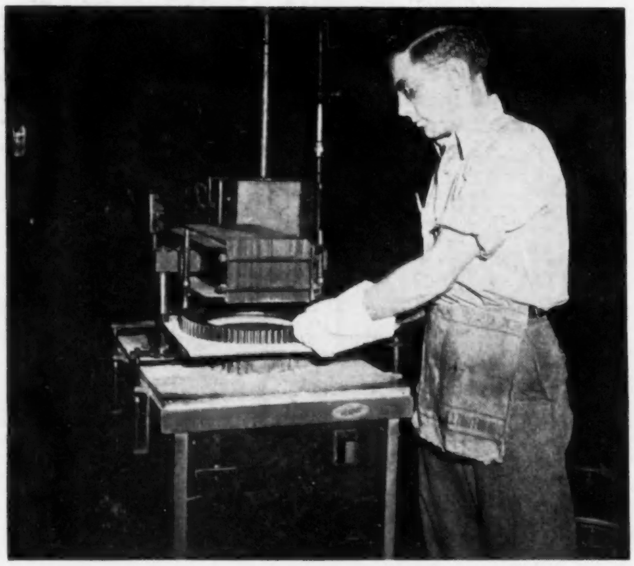
Fig. 5 shows the dynamometer performance of certain 7-pitch gears which were induction hardened by both AF (audio frequency) and RF (radio frequency) methods. Note that all of these gears withstood the 125% stress for 10,000,000 cycles without failure. Subsequent tests at 150% and 175% produced failures after 600,000 to over 10,000,000 cycles of stress.

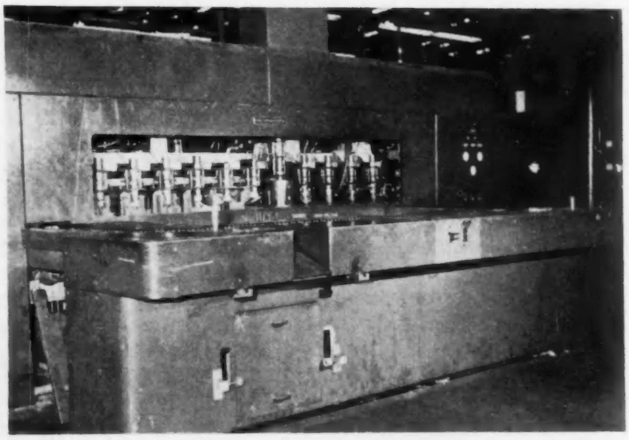
Also note that these data show no advantage for one of these methods over the other, so far as these particular gears are concerned. This illustrates again that satisfactory induction hardening can be accomplished by different methods, provided the technique is worked out to produce the desired properties and residual stresses in the final gear.

Fig. 6 shows the dynamometer results on gears varying from $2\frac{1}{2}$ to 8-pitch. For comparative purposes these are all plotted in terms of calculated stress versus number of cycles to failure, rather than in terms of percent of service load. This graph does not include all of the data which have been acquired, but does cover the entire range of bending stress which has been studied. Results on other gears fall within this band. In other words, the observed bending fatigue strength of different types of induction hardened gears varies from approximately 40,000 to 65,000 psi. But the actual fatigue strength would not show such a wide variation . . . the formulas for calculating stresses do not include all of the factors involved in the design and machining of gears.

Induction-Hardening Equipment . . . .

EXCERPTS FROM PAPER BY **H. F. Kincaid** Assistant Works Metallurgist International Harvester Co.

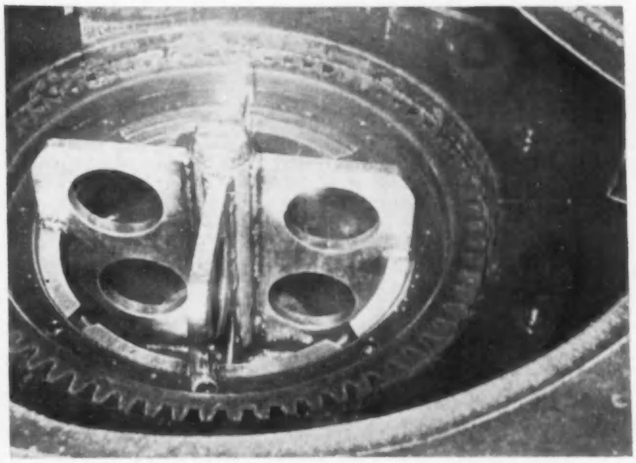




FINAL DRIVE GEARS are hardened using a three-station remote unit with a special arrangement for rotating and indexing the gear from inductor into the oil-quench ring using AF power at 9600 cycles. Two-piece gears are hardened before assembly on a hub or carrier. These gears are preheated before hardening using a 60-cycle induction unit, at left. With this heating method the gear becomes a short-circuited secondary of the iron core transformer. Heating takes place throughout the gear.

Other type gears are handled by two six-station

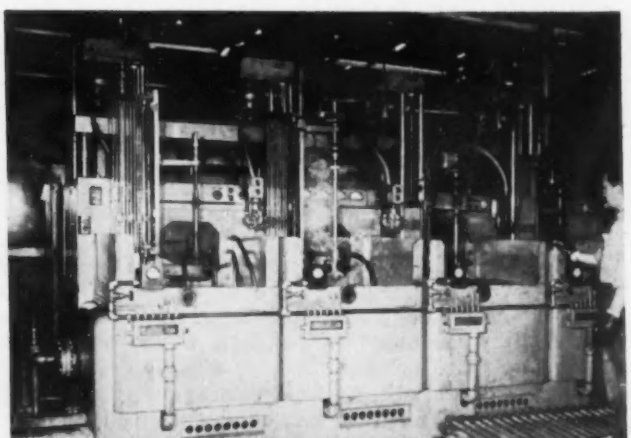
remote units equipped with Toccotrol fixtures for positioning in inductors and indexing to quenching position when necessary. Shown at right on previous page is a partial view of the 12-station hardening installation powered by two 150-kw, 9600-cycle water-cooled generators. This power is made available at any or all of the individual stations through a switching mechanism. Some gears are quenched within the inductor coil where the heat removal is not great enough to present a fire hazard.



FINAL DRIVE GEAR for the largest Farmall-type tractor is induction hardened. Shown at left is the preheat furnace and one gear-hardening machine. This gear is 18 in. in diameter, with 1 13/16-in. face and is 4-pitch. The teeth and steel below the roots, to a depth of about 1/8 in., are through-heated with AF power at 9600 cycles, as shown at the right. The gear then is lowered into a quench ring at the bottom of the tank where it is pressure oil quenched. The quench starts with an open spray and a few seconds later the gear and quench ring are submerged for the rest of the cycle.

After hardening, the gears are drawn at about 400 F in a furnace identical to the preheat furnace. The gears are taken from the draw furnace and placed on a rack where the carrier hubs are installed. The rack then is lowered into the water for shrinking the gear to the hub.

TRACTOR GEARS, particularly the heavier types, have been the subject of much induction hardening pioneering. These gears are about 32 in. in diameter with 4-in. face and 2.5 pitch. The gears are preheated in a furnace to 600 F prior to induction hardening. They are then taken from the preheat furnace and placed in a special hardening unit (shown above), equipped with a rotating spindle and indexing cylinder for lowering the gear from the inductor into the water-spray quench ring, located in the bottom of the tank.



TRANSMISSION GEARS are handled by this equipment, which provides a very high speed method of hardening and tempering.

Gears are placed in trays on an endless circular track which carries the gears automatically through the machine. A bridge with 10 rotating spindles

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picks up the gears from trays and lifts them into inductors. Every gear enters each of the nine inductors as it progresses along the track.

Trays and bridge are indexed with air-operated cylinders, controlled by micro limit switches and electric solenoid air valves. A timer controls the "dwell" of the gears within the inductors to control preheat and draw temperatures.

Production rates on this machine vary from 550 to 900 or more gears per hr. Quench time and preheat requirement control the speed of operation. RF heating time remains nearly constant for all sizes of gears. RF kilowatt output is the only variable used to produce proper RF heating.

Induction-Hardening Processes . . .

EXCERPTS FROM PAPER BY **John A. Redmond** Electronics and X-Ray Division Westinghouse Electric Corp.

INDUCTION heating is an ideal medium for surface hardening because only the surface of a piece of metal need be heated to above the hardening temperature. Depth of surface layer heated depends on the frequency of the induced currents, power level used, and length of time that the power is applied.

Effect of various heating times and power levels on heating gear teeth is very well illustrated by Fig. 7. Shown here are macrographs and photomicrographs of four 8-pitch gears heated at different power levels at 340 kc.

Gear "A" was heated in 0.52 sec with a power level of 41 kw oscillator plate input per square inch of pitch circle area. Macro No. 3, taken at right angles to the tooth, shows that only a thin surface layer has been heated above the hardening temperature.

The heated area is uniform along the tip of the tooth shown in macro No. 1. The case in the root is very thin and is not uniform along the entire root. Although they do not show very well, there are two soft striae about 1/8 in. from each face. The corners of the root radius are more deeply heated than the rest of the root radius. The photomicrographs show incomplete solution at both the tip of the teeth and the roots.

Gear "B" was heated at the same power level, but for 0.75 sec. The result was a deeper higher hardness on the tip of the teeth and elimination of the striae in the root. The case in the root is not much deeper than the first example, but has slightly better metallurgy.

Gear "C" was heated for 0.97 sec at the same power level as gears "A" and "B." Result was that more of the tooth was heated without any improvement in the hardness of the root radius. These examples show that there is no appreciable improvement by increasing the heating time. Higher power densities would give some improvement, but it makes total power requirements too high to be economical.

Gear "D" was heated at a low power level for 14.5 sec. This is an example of a through-hardened gear. Gears of this type have found application where the loads are relatively light. Gears of this type are usually made with 3000 or 10,000 cycles obtained from motor-generator sets.

It has been found that preheating the gear before application of RF (radio frequency) power for hardening makes necessary less RF power to bring the steel up to the hardening temperature. This is important if gears are to be made with RF generators of economical sizes.

Induction heating with 10,000 cycles has been found to be the most suitable means of preheating. By induction, the preheating could be restricted to a relatively narrow band comprising the teeth of the gear and the steel a short distance below the roots.

In preheating it has been the practice, in some cases, to heat above the hardening temperature and then allow the gear to cool down before the RF is applied. This places the steel in solution by the preheating. The pretreatment obtained makes it easier to get good metallurgy in the relatively short time that RF power is applied. This pretreatment also produces a slightly higher core hardness.

Power necessary to preheat a gear will depend on the size of the gear and the frequency used. Although there is some latitude in the value chosen, the best results are obtained with a preheat time about equal to the delay time between the end of the preheat and the hardening operation. The gear teeth should be raised above the hardening temperature during the preheat. This delay should be sufficient to allow the gear teeth to cool to about 1100 F before RF power is applied.

Photomicrographs and macrographs of a typical

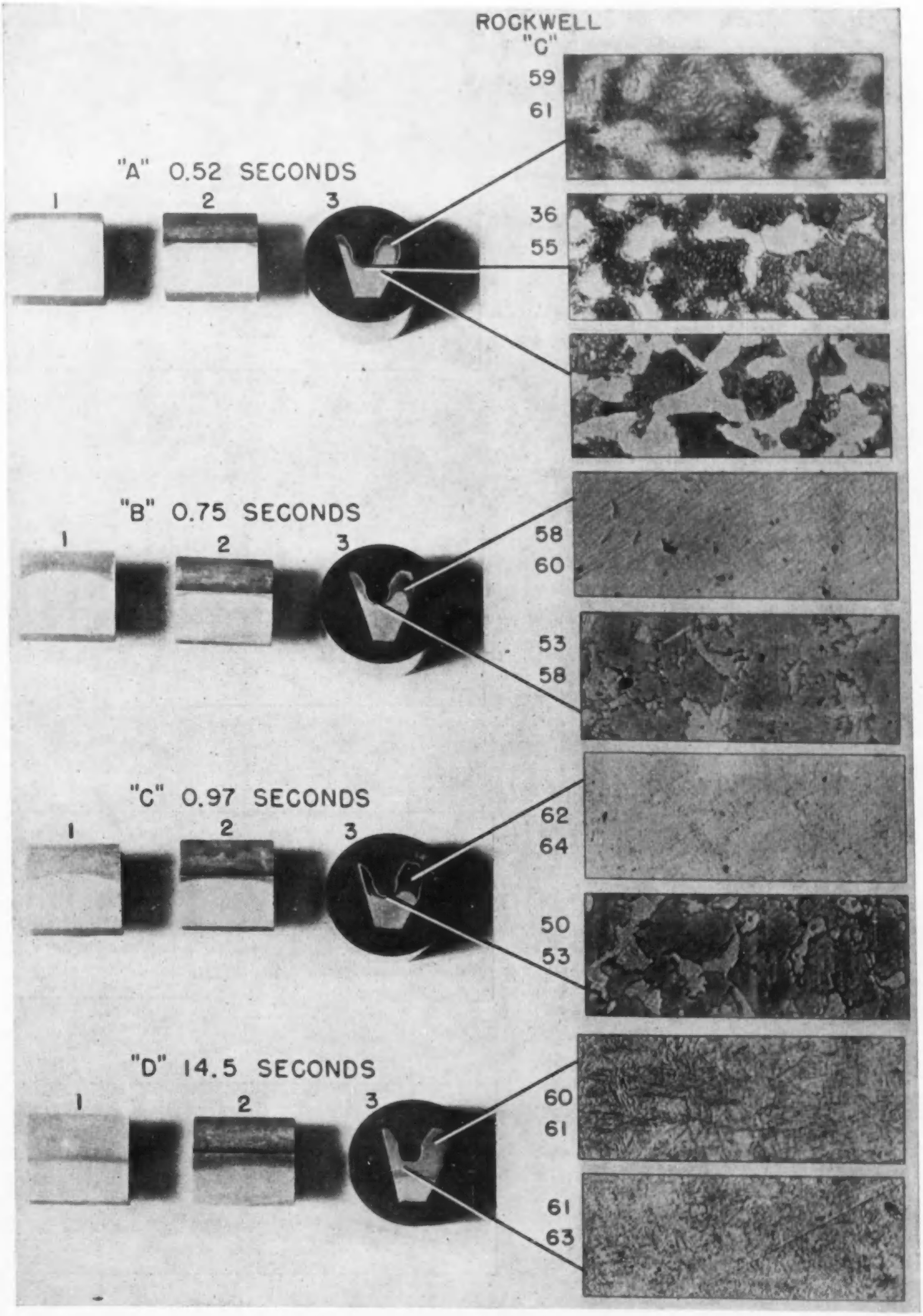


Fig. 7—Shown in these macrographs and photomicrographs are the effects of various heating times and power levels on induction-hardened 8-pitch gears, without preheat. Gears "A," "B," and "C" were heated at 41 kw and gear "D" at a low power level; heating time for each gear is as indicated. The photomicrographs at right are magnified 600 times

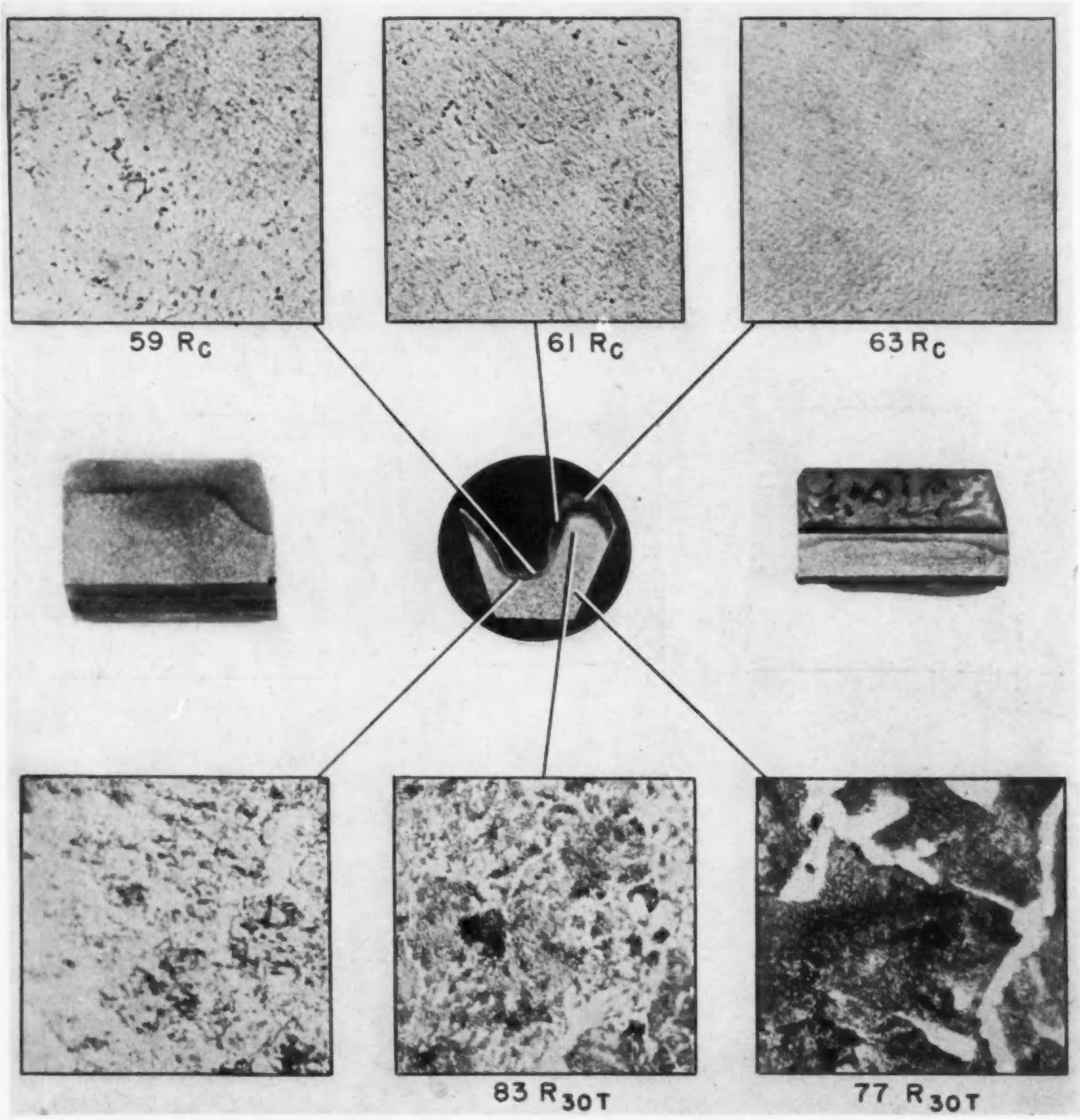


Fig. 8—This RF induction-hardened 5-pitch gear, of normalized 1050 steel, was preheated with 10,000 cycle power. As the photomicrographs show, the case is over 60 Rockwell C to below the pitch line and 55 to 59 Rockwell C in the root

induction-hardened surface gear are shown in Fig. 8. This is a 5-pitch tractor gear with one clashing surface. The case is over 60 Rockwell C to below the pitch line and 55 to 59 Rockwell C in the root. The root hardness is uniform across the gear, with no indication of striae.

The hardness has been brought down over the clashing surface by a projection on the work coil. The macrograph taken through the tip of the tooth shows the effect of the preheating. The photomicrographs show the change in the structure of the core due to preheating.

Following are some of the advantages of using induction surface hardening for gears:

1. It is a one-at-a-time heat-treating method that will fit into modern production methods. Presently used equipment does not completely fulfill this, but future equipment will.

2. Since the spline and hub of an induction surface hardened gear are not heated, distortion is small. In carburized gears it is often necessary to finish the splines after heat treating, or to quench on an arbor in an effort to hold the spline dimensions.

3. If the production is reasonably high, the labor and investment cost to heat-treat by induction will be less than the cost to carburize.

4. A one-at-a-time system accrues a big saving in handling and trucking. The gears can be hardened as they come off gear cutting machines one at a time, or in small lots.

5. It eliminates large backlogs of gears and costly furnace shutdowns.

6. In some cases a cheaper medium carbon steel will replace a more expensive alloy steel.

7. Cleaner, cooler working conditions result.

No More Skids for Airplanes!

BASED ON PAPER* BY **Arthur J. Bent** Westinghouse Air Brake Co.

SKIDDING—one of the greatest hazards in aircraft landings—can now be brought under automatic protection by means of a device known as the Decelostat[1] controller which detects and eliminates a skid in a fraction of a second.

The control of this dangerous condition means that greater safety can be attained because tire blowouts are eliminated and steering is easier. It also means that higher average braking pressure can be maintained, which shortens stops and reduces tire wear. (Even on wet runways, tests indicate that an average retardation rate exceeding 10 ft per sec per sec can be maintained.)

The Decelostat controller—similar in design to one long used successfully on railroad cars to avoid flat wheels—weighs less than 5 lb per wheel, including its valve. It can be applied to both pneumatic and hydraulic brake systems and to any type or size of wheel or brake.

How It Works

Fundamentally, the operation of the device is based on the relation of the deceleration rate of an energy wheel to the deceleration rate of the airplane landing wheel or axle. Under normal landing conditions, the energy wheel in the decelostat synchronizes with the landing wheel. Should the rate of retardation exceed a predetermined value, however, the energy wheel will overtravel, operating a valve to interrupt the brake pressure and release the brakes. The moment the landing wheel resychronizes with the energy wheel, brake pressure is restored.

A typical installation of the Decelostat controller on landing gear of the tandem type is shown in Fig. 1.

Details of Operation

Fig. 2 shows a cutaway view of the Decelostat controller and its valve.

The Decelostat controller is mounted directly on the plane wheel. The valve is mounted on a sta-

Fig. 1—Typical Decelostat controller installation on tandem type of landing gear

[1] Reg. U.S. Pat. Off.

* Paper, "Aircraft Decelostat—A Device for Wheel Slide Protection," was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 8, 1949. (This complete paper is available from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

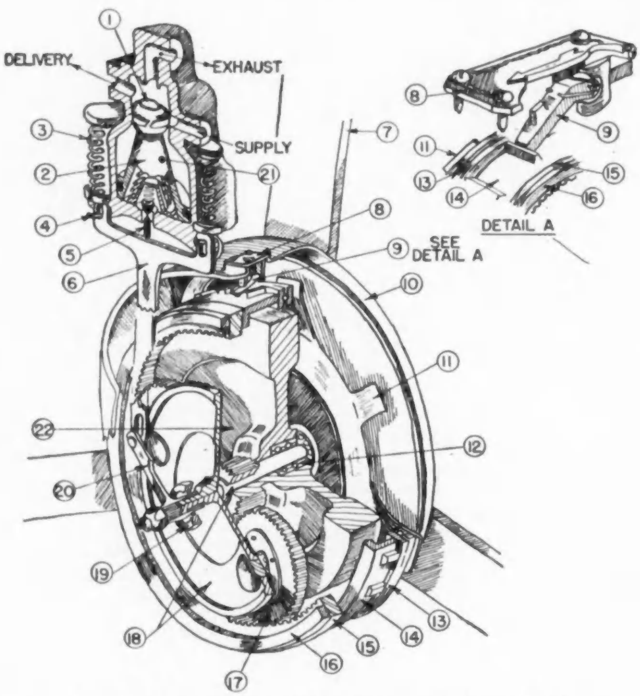


Fig. 2—Cutaway view of Decelostat controller and valve

tionary part, such as the strut, but it is connected to the controller by lever arm 20. On touchdown, as housing 10 comes up to speed (with the wheel), clutch spring 11 creates a force tending to rotate together bearing ring 13, clutch 14, ring gear 15, washer 16, and housing 10.

At this instant, however, inertia wheel 22 is at rest. This wheel is connected to ring gear 15 through idler pinions 17. During the initial part of the plane wheel acceleration, when the acceleration rate setting of the valve is exceeded, idler pinions 17 carry spider and shaft 18 to the extent of travel of lever arm 20 (which is limited by the distance through which the operating lever can move).

Since the force of clutch spring 11 is less than that required to "pick up" inertia wheel 22 under the initial high rate of wheel acceleration, ring gear 15 slips between clutch 14 and washer 16. The inertia wheel is driven in the opposite direction from and at a speed seven times greater than that of the ring gear, due to the gear ratio involved. When wheel 22 has been brought up to full speed, graduating spring 3 forces operating lever 6 back to its neutral position. At this instant, housing 10, clutch spring 11, bearing 13, clutch 14, ring gear 15, and washer 16 are traveling at the same speed and in the same direction as the plane wheel. Spider and shaft 18 and lever arm 20 are stationary, while idler pinions 17 drive inertia wheel 22. When brake pressure is applied to the Decelostat valve, it equalizes on both sides of piston 2 through orifice 21, allowing the piston spring to keep the piston in its upper position, sealing off the exhaust port and connecting the supply pressure to the brakes through the delivery port. With the operating lever in neutral, pilot valve 5 remains seated by its spring and fluid pressure.

Effect of Slide

As the wheel starts to slide, housing 10 slows down. For ease of explanation, we can assume that the wheel stops, so that housing 10 is also stopped. Inertia wheel 22, which has been driving pinions 17, now carries spider and shaft 18 and lever arm 20 clockwise as far as lever 6 permits, thus opening pilot valve 5. Pressure is then exhausted from the underside of piston 2, moving it down to cut off the supply pressure and open the delivery port to the exhaust, thus releasing the brakes.

As the brakes are released, the plane wheel picks up speed. Again, let us assume that the inertia wheel has stopped. Ring gear 15 driven by housing 10 again moves spider and shaft 18 counterclockwise to the opposite limit of travel of lever 6. The cycle is then repeated, as in the initial touchdown, bringing the interia wheel up to speed and returning lever 6 to neutral, allowing brake pressure to be reestablished.

For ease of explanation, we have assumed extreme conditions that actually are never reached. When the plane wheel deceleration rate exceeds that above which a normal stop (without sliding) can be made, the Decelostat controller functions instantly to initiate brake release. As the wheel accelerates back to its normal speed, the Decelostat controller again initiates brake release to ensure against full braking being applied until normal speed has been obtained. These two brake releases (deceleration and acceleration) occur in such rapid succession that they appear as one. As the plane wheel acceleration rate decreases to zero, indicating normal speed, the Decelostat controller functions instantly to restore full brake pressure. The degree of brake release is dependent on the time for the cycle, which in turn is dependent on ground coefficient, wheel loading, and brake pressure. Since the Decelostat controller "reads" the action of the wheels individually, it automatically compenstates for all conditions to maintain the maximum retarding force throughout the stop.

Clutch Arrangement

In order to minimize the time required to obtain full braking after the wheel has attained normal speed, the clutch arrangement shown in detail A (Fig. 2) has been included.

Latch 9 is attached to latch cover 8, which is connected to housing 10. This latch engages with clutch 14, which rides between bearing ring 13 and ring gear 15. Ring gear 15 in turn rides on washer 16, which acts merely as a wearing plate and may be considered integral with the housing. As the plane wheel begins to slide, the ring gear is driven counterclockwise by the inertia wheel, as already explained. The clutch is free to rotate in this direction on bearing ring 13 and is carried with ring gear 15, which slides over only washer 16; thus the housing can drive the ring gear through only one friction

element. The energy extracted from the inertia wheel during a skid is, therefore, reduced to the minimum necessary to operate the Decelostat valve plus a reasonable margin. As the wheel picks up again, however, the ring gear (which attempts to remain stationary, due to its connection to the inertia wheel, which we are assuming is completely stopped) is picked up on one side by the friction of the clutch, which is being turned in this direction by the housing through latch 9, and on its opposite side by washer 16; thus, two frictional elements help to bring it up to speed. By these means, the rate of acceleration of inertia wheel 22 becomes twice that of deceleration. This allows the brake pressure to build up more quickly as the wheel reaches normal speed.

Latch 9 may be turned 180 deg to accomodate mounting on the outboard side of either left or right wheels by removing four screws holding latch cover 8 and placing the arrow on the cover in the direction of wheel rotation.

Some Test Results

Figs. 3 and 4 show test results for the B-26HM with tandem gear, using one Decelostat controller per wheel.

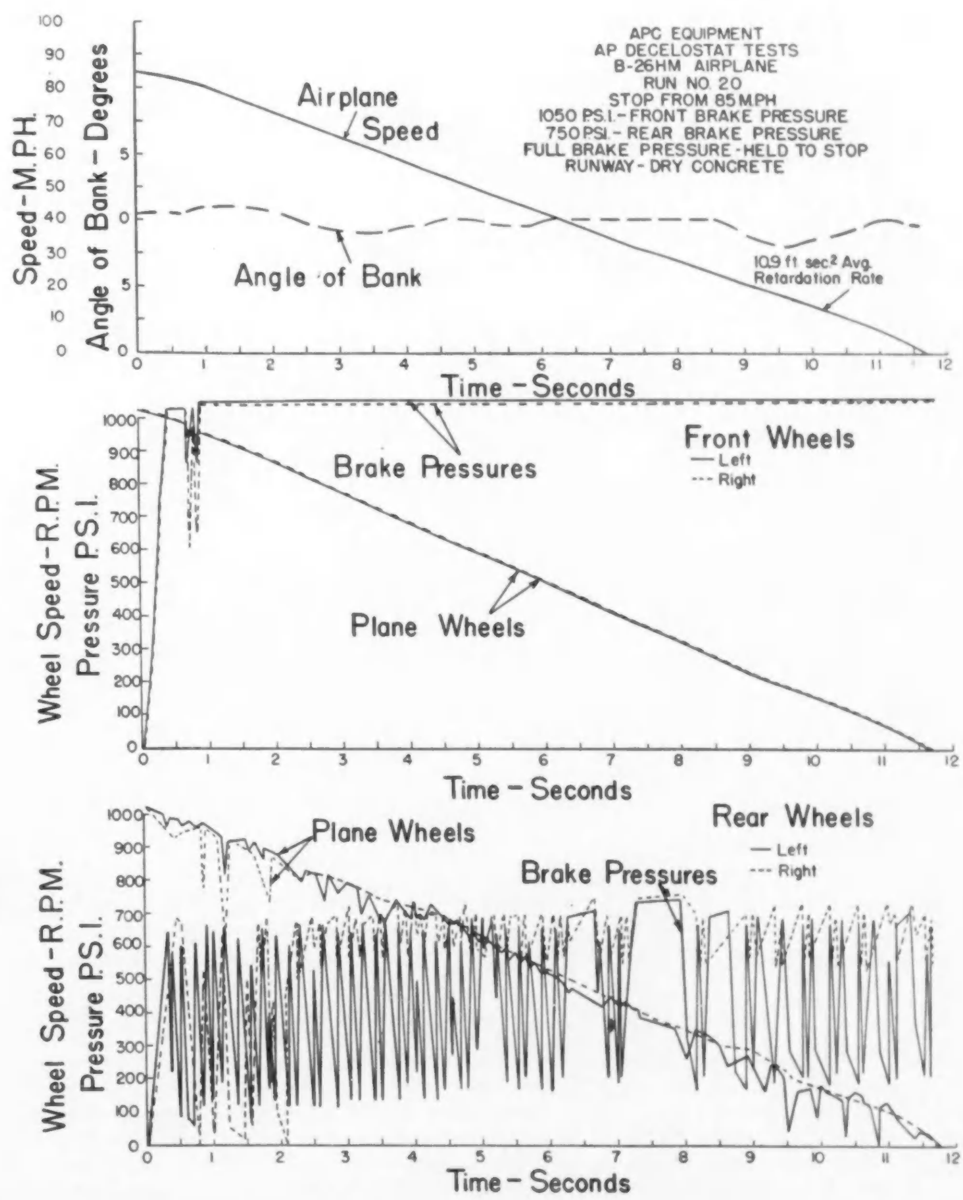


Fig. 3—Characteristic dry runway stop with B-26HM airplane

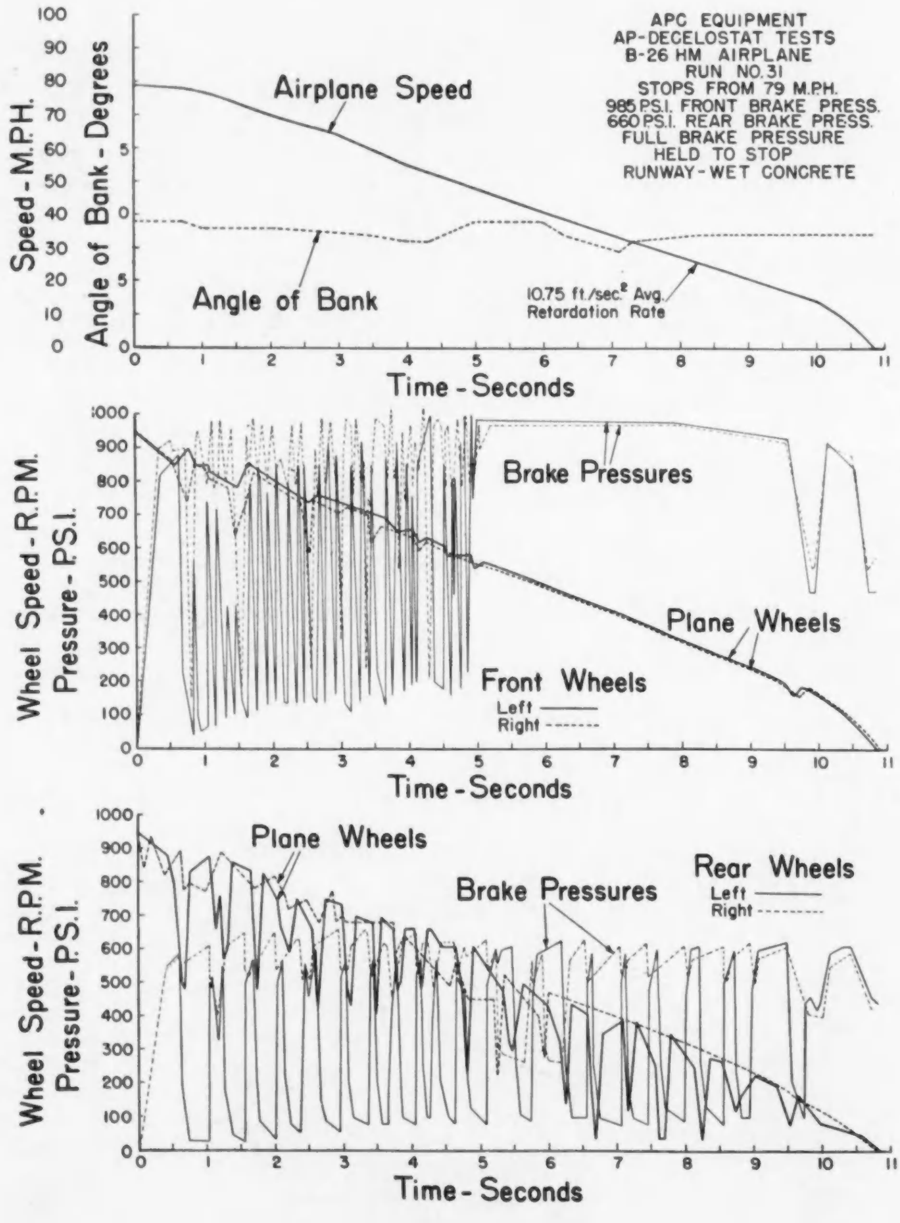


Fig. 4—Characteristic wet runway stop with B-26HM airplane

Fig. 3, a typical stop record from 85 mph on a dry runway, shows two releases on the right front wheel, none on the left front, six on the right rear, and 55 on the left rear wheel.

Load Transfer

The greater number of releases on the rear wheels is due to load transfer caused by a high deceleration rate. The difference in the number of releases between the two sides is due to the difference in loading on the wheels because of the angle of bank of the plane. The stop was accomplished in 11.7 sec, giving an average retardation rate of 10.9 ft per sec per sec.

A similar stop record from 79 mph (Fig. 4) on a wet runway shows eight releases on the right front wheel, 29 on the left front, three on the right rear, and 19 on the left rear. This stop was made in 10.84 sec, giving an average retardation rate of 10.75 ft per sec per sec.

During this stop more releases also occurred on one side than on the other. Also evident is a greater number on the front wheels, which may be because of wheel loading, due to weight transfer; or possibly the front wheels conditioned the runway surface to provide a higher coefficient of friction for the rear wheels. The rate of retardation indicates the effectiveness of the Decelostat controller when it is realized that any of the releases would have resulted in a sliding wheel, had the brake pressure been kept on.

Auxiliary Power for Large, Turbine-Powered Aircraft

BASED ON PAPER* BY **H. J. Wood and F. Dallenbach**

AiResearch Mfg. Co.

* Paper "Auxiliary Gas Turbines for Pneumatic Power in Aircraft Applications" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 8, 1949. (This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

An all-pneumatic system is proposed that is believed to represent a practical solution to the problem of supplying auxiliary power for large, turbine-propelled, multiengine aircraft up to altitudes as high as 50,000 ft.

The compressed air is obtained by extraction from the compressors of the main propulsion engines and from a special form of auxiliary gas turbine.

The power needed at high altitudes is supplied by the main engines, either alone or in conjunction

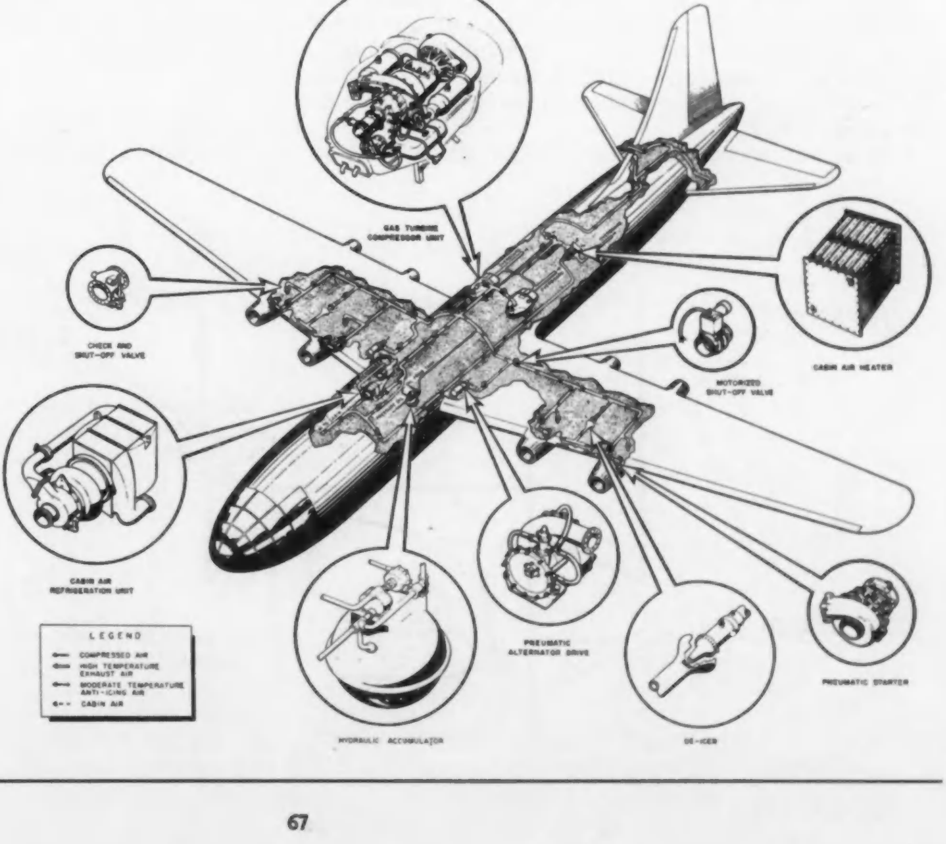


Fig. 1—Hypothetical airplane with pneumatic power system

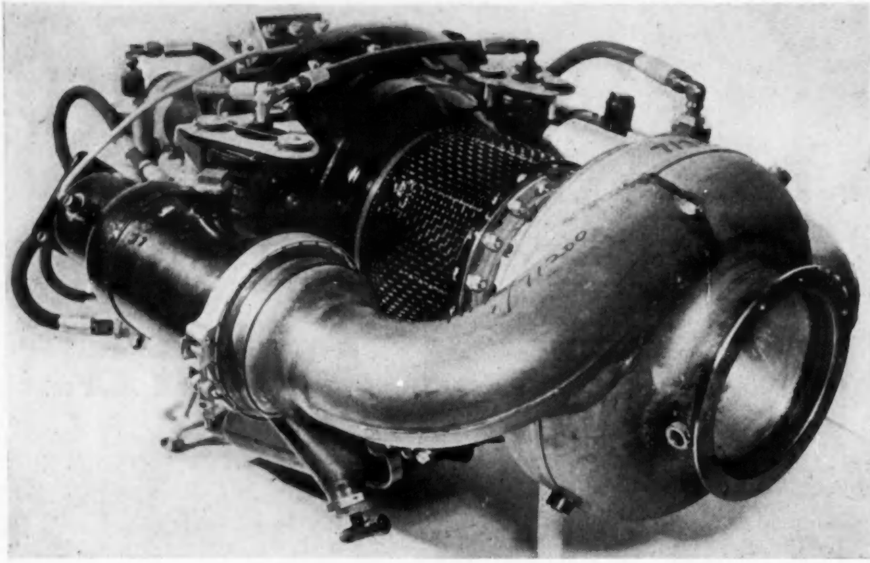


Fig. 2—Gas turbine compressor unit

with the auxiliary units. At low altitudes most of the power is supplied by the auxiliary turbines—and all of it when the main engines are inoperative. The auxiliary turbines can also supply power to start the main engines.

In the proposed system, the compressed air is used at low pressure (that is, at the pressure at which it is bled from the compressor of a gas turbine) for all applications where a continuous supply of low-energy power needed, such as for cabin air conditioning and pressurization.

Some devices, however, such as the landing gear and the flaps, need intermittent surges of power for their operation. This can be provided by high-pressure accumulators charged by booster pumps. This actuation can be hydraulic or pneumatic, as discussed later.

The remainder of the compressed air is used to drive power turbines, which are connected with alternators and d-c generators to provide all the electricity needed for the plane. It can also be used to drive the pneumatic turbine starter on each main engine.

Before the compressed air is used to drive these power turbines, however, it is mixed with fuel and burned to raise its temperature. This "bleed and burn" arrangement, as it is called, allows the air to be used more efficiently than if power is obtained merely by expansion of the bleed air. It means lower specific fuel consumption and it conserves the compressed air supply as much as practicable.

Hypothetical Airplane

In order to show how the all-pneumatic system as envisioned can meet the auxiliary power demands

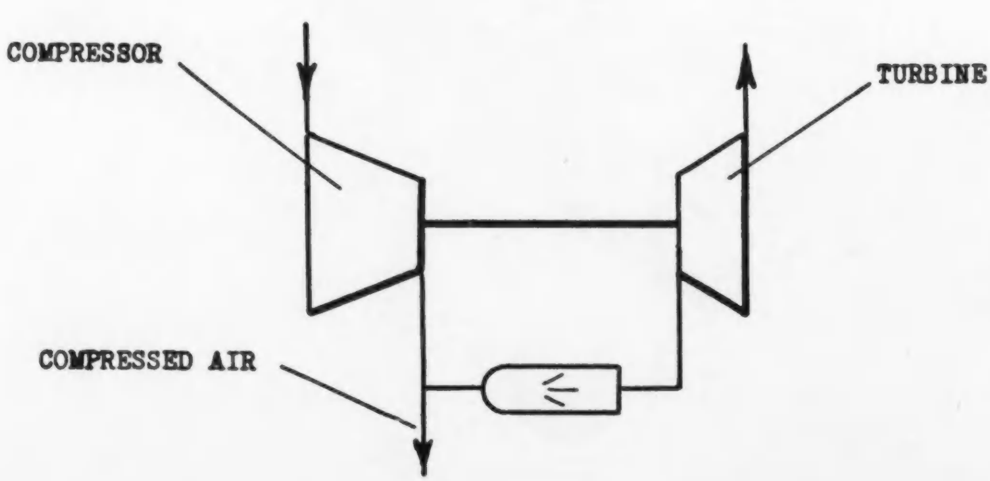
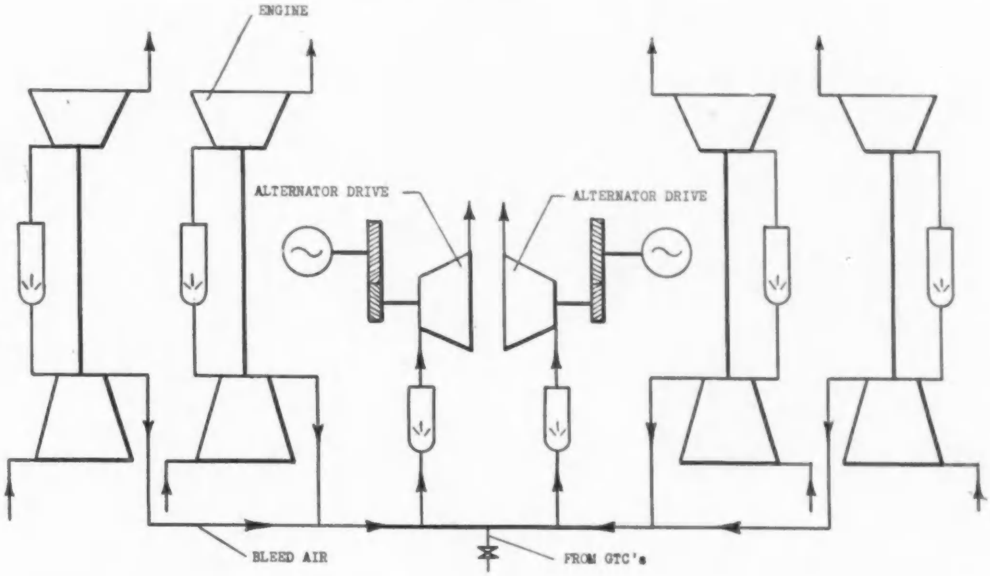


Fig. 3—Schematic diagram of gas turbine compressor unit

Fig. 4—Schematic diagram of simplified bleed-and-burn system for 2-turbine arrangement and four engines



of large aircraft, a hypothetical airplane with four engines of about 10,000-lb thrust rating and a gross weight of 175,000 lb will be considered.

The auxiliary demands of this airplane (based on an estimate of the auxiliary power requirements likely to be encountered on aircraft in the next few years) are considered to be:

1. Cabin air conditioning, including pressurization, refrigeration, and air circulation. Heating is not considered to be a power function.

2. Radar and radio electrical current.

3. Miscellaneous electrical loads, including lights, small fans, and instruments.

4. Gun controls, including operation of computers, and turret mechanisms.

5. Control booster servo systems.

6. Flap, landing gear, bomb door, dive brake, and similar intermittent actuations.

7. Wing de-icing in so far as air circulation power is involved.

8. Main propulsion engine starting.

To take care of the normal electrical load demand of the plane 200 kw are needed. The overload demand is 300 kw for a maximum of 5 min. The major portion of the electrical load is required in the form of 400-cycle a-c current, although some 120-v d-c current is needed, too.

Suggested Power System

Fig. 1 shows the pneumatic power system suggested for this airplane. Two auxiliary gas turbine compressor units feed air into a common air pressure manifold, which may also be supplied with air bled from the compressors of the four main propulsion engines.

Figs. 2 and 3 give a better idea of how this auxiliary compressor looks and works. Actually, this unit is similar to a conventional turbojet, except for a few differences: The total pressure drop across the turbine is substantially equal to the compressor pressure rise, and a portion of the compressor air is diverted from passage through the turbine. Since the turbine output power matches the compressor power absorption, the only useful work is in the form of compressor bleed air. By combining of compressor functions, a weight and size, for a given

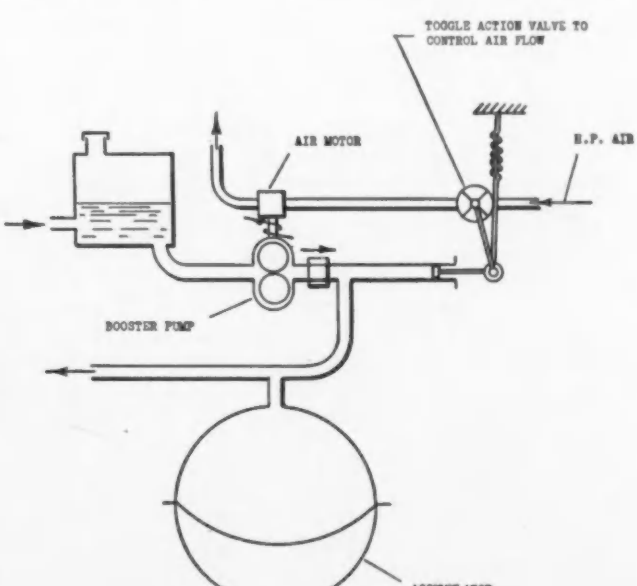


Fig. 5—Schematic diagram of booster pump and hydraulic accumulator

Fig. 6—35-hp air turbine starter

air compression rating is obtained that is better than is possible by a combination of engine and compressor as separate elements.

Electrical power is obtained from the compressed air in the manifold by means of a pair of power turbines, each of which drives a gearbox on which is mounted a 90-kw alternator and a 10-kw d-c generator.

Each of the power turbines has a variable-area nozzle (to regulate turbine power output) and an automatically regulated combustion chamber, which maintains a constant gas temperature. The fuel pressure is supplied by a pump on the alternator drive gearbox. The compressed air for the turbine may come, of course, from either the auxiliary turbine compressor units or the main engines. The two main alternators are run in parallel and are synchronized. Provisions are made for isolating portions of the compressed air manifold through shutoff valves in the event of damage to a particular section.

Fig. 4 is a schematic diagram showing how the alternators and their power turbines are hooked up to get air from either the main engines or from the turbine compressor units. This diagram also shows how the bleed air is burned before it is fed to the power turbine—thus increasing the power obtained from it.

Landing gear, flaps, bomb doors, control servos, and similar devices actuated intermittently are handled by high-pressure accumulators with booster pumps, as shown in Fig. 1. A pneumatic booster system and a high-pressure hydraulic accumulator are shown in more detail in Fig. 5. Instead of hydraulic accumulation, direct storage of air at high pressure for pneumatic actuation can be used. One advantage of this system is that the pumping means does not move unless there is a load demand—as contrasted with the conventional engine-driven pumping means, which are subject to wear, whether they are in use or not. By mounting the booster pump directly on the accumulator, a neat "power package" may be achieved.

The cabin is air conditioned with air bled from the main manifold and passed through an air-cycle refrigeration unit subject to modulation to meet demands. This same compressed air serves, of course, to pressurize the cabin. The cabin can be heated with the exhaust heat of the gas turbine compressors.

Wing de-icing is accomplished by using air bled from the compressed air manifold through the nozzle of a jet pump to force an airflow through a combustion heater or by inducing the exhaust flow of the gas turbine compressors with the jet pump. Obviously, the location of the surfaces and the problem of ducting hot gases determine whether or not exhaust heat or combustion heater heat shall be used.

Engines can be started with a pneumatic turbine starter installed on each engine. Compressed air for the starters is also taken from the main air manifold. (Fig. 6 shows a 35-hp turbine starter.)

Conspicuous by their absence are a lot of small pneumatic turbines driven from the main manifold. The reason for this is that air turbines used for less than 15- or 20-hp output must be driven at such high rotative speeds that the design of reliable, lightweight gearboxes, reversing mechanisms, and actuator brakes is very difficult. Furthermore, the high-speed bearings involved are subject to brinelling when held idle for long periods of time under airplane vibration conditions. The high efficiencies possible with small wheels are very difficult to develop in actual aircraft power service because of the impracticability of controlling them to operate in their efficient regions. Accordingly, for all service where intermittent power surges are needed, small turbines are not recommended, rather the booster pump and accumulator system represents a better solution.

Weight Figures

Dry weight of the complete auxiliary drive, including gearbox, power turbine, combustor, controls, and enclosure is estimated to be 75-100 lb per drive, depending on enclosure and special installation conditions. The 70-hp air turbine starters needed to match the 10,000-lb thrust engines would weigh about 28 lb a piece. Each of the two gas turbine compressor units to match the starter load would weigh, complete with enclosures and automatic controls, between 150-200 lb, depending on installation considerations. Thus, the total weight of two auxiliary drives, four starters, and two gas turbine compressor units would be 562-712 lb.

This represents a system that can produce 140 hp at the starter jaws or develop more than 320 hp to drive electrical equipment. These figures do not include duct and valve weights, because the evaluation of such elements is very much dependent on the specific airplane. Furthermore, a considerable portion of such duct weight is chargeable to normal pressurization and wing de-icing systems.

It is believed that no other system can better the above weight figures, if all of the functions involved are included.

AIR CARGO DAY

AIR cargo operations received recognition as a vital part of the air transport industry with their own peculiar requirements at an Air Cargo Day, November 29.

Air Cargo Day, cosponsored by ASME, SAE, and IAS, was held as part of the Annual Meeting of the ASME in New York. Scheduled, nonscheduled, and military operators; airframe and engine builders; and materials handling experts gathered to hear five technical papers—four of them authored by SAE members—presented in morning and evening sessions. The afternoon was spent inspecting cargo airplanes and cargo handling facilities at Newark Airport.

Throughout the discussions ran the sentiment that commercial and military operators must get together on their requirements so that both can use the same basic aircraft designs. With the military services standing a major part of the development costs and the commercial operators buying the airplanes, three advantages were forseen for the country:

1. Commercial operators will enjoy the economies of aircraft designed specifically for cargo use and should be able to drop prices to levels that will enlarge their volume.
2. The increased volume of business will generate a demand for the products of airframe and engine builders that will keep them in business with less cost to the taxpayer.
3. In case of war, we will have active, expandable design and production facilities—plus a sizeable number of aircraft and operating personnel available for quick diversion to military needs.

Such a fleet Dr. Hugh L. Dryden advocated as a guarantee of peace, calling it a worldwide counterpart of the policeman's revolver which maintains peace on a local scale. Dryden, who is NACA's director of research, spoke at a luncheon for which Air Cargo Day participants joined those of three additional ASME divisions.

Commercial and military operators did get together—in a spirit of cordiality and cooperation. Basically, they found, their requirements are similar. Both groups pleaded for simplicity of operation, simplicity of maintenance, and durability above all else in their equipment. They want airplanes that can carry big loads and airplane interiors that can stand them. Speed they like, too, but not at the expense of capacity or economy. At present, there is more need for speeding up ground handling than flight, commercial operators proved.

An airlines spokesman proposed two sizes of cargo aircraft: a 10,000-20,000-lb-payload model that could

Participants in Air Cargo Day survey model of Lockheed's proposed air terminal

Chairman for Air Cargo Day was **Robert B. Lea**, who was assisted by **Herman Hollerith** as vice-chairman.

This report is based on discussions and five papers. . . . "Air Cargo Today—Here to Stay," by **Charles Froesch**, Eastern Air Lines, Inc.; "What Should Be Done to Improve Cargo Aircraft," by **W. W. Davies**, United Air Lines, Inc.; "Improvements Required in Air Cargo Ground Handling," by **R. Dixon Speas**, American Airlines, Inc.; "Experience and Future Requirements of Military Air Cargo," by **Major-Gen. William H. Tunner**, Military Air Transport Services; and "Planning the Air Cargo Terminal," by **R. L. Hackney**, Lockheed Aircraft Corp. . . . as well as the Newark Airport tour. **Hugh L. Dryden** was luncheon speaker.

cover a range of 500-1500 usable miles at 300 mph and a 20,000-30,000-lb-payload model to cover 1000-3000 miles at 400 mph. MATS (Military Air Transport Service) expressed preference for an airplane capable of carrying loads up to 50,000 lb for 3000 miles at 250 mph.

Both groups will appreciate higher airplane speeds if they can have them without sacrificing operating economy. In fact, the ideal of the commercial operators is to fly across the country in six or seven hours, leaving New York at midnight and arriving on the Pacific Coast at 3 or 4 a.m.—if it is economically feasible. But even 250 mph, it was noted, gives a comfortable margin over surface transport.

Both groups want their aircraft to be able to operate from presently available fields. The military added that airplanes should be able to climb rapidly to 20,000 ft. They want them to be simple enough for operation by three crewmen over land and not more than five over water.

No preferences for particular types of powerplants were expressed. Instead, civilians and military men alike talked of the need for economy of operation and maintenance and of dependability. MATS wants to be able to run its engines 1200 hr between overhauls and to replace them in a few minutes.

High-wing and low-wing aircraft each had their advocates. Arguments for high-wing, low-fuselage aircraft centered around the fact that their floors can be level with truck floors, making direct loading easy. This is especially advantageous for service in and out of small airports without elaborate terminal facilities. But low-wing, high-fuselage aircraft are better able to absorb the energy of a crash landing and to stay afloat after ditching at sea, their backers explained. Military air transport experts pointed out that, since a considerable part of their work will always be over water, they must have ditching safety in any design they use.

Two solutions were suggested:

1. Use low-wing aircraft and build up loading platforms and truck ramps.
2. Build high-wing aircraft with special provision for protecting crew, if not cargo, in case of crash landings.

The philosophy that safety of human life is to be valued over equipment guided both groups. While the military stressed crew safety in case of ditching and crashes, commercial operators, thinking more of operating in and out of populous areas, stressed preservation of exterior safety as well. The airlines' answer to a suggestion that special C.A.R. categories be set up for cargo aircraft was that they are not interested in any modifications that might lessen safety of people near or under their aircraft. Increased loadings are attractive to them only with equivalent safety.

To get the loads in and out of the aircraft easily, operators want two or more large doors. An air express operator explained the need for several doors the size of truck rear-openings on each side of the airplane to facilitate loading and unloading at en route stops. A contract carrier requested aft-end doors large enough to take ship shafts. A discusser familiar with the requirements of the Army field forces called for a doorway with a drive-up ramp plus two 3 x 6 ft doors for emitting paratroopers and larger doors for parachuting equipment. (Airframe builders in the audience cringed a little at the thought of trying to adjust one basic design to provide all these arrangements in different models.)

Rugged Interiors Needed

Inside the airplane, operators want a tough, light-reflecting wall surface, sturdy floors without protuberances, and plenty of tiedown fittings. They reported that cargo nets are best for securing the small packages that constitute the bulk of commercial cargo but that heavy pieces require ropes with toggle arrangements for snugging. The military need tiedown fittings to hold up to 50,000 lb pieces. They want to be able to restrain tanks to 3 g forward acceleration. All tiedown equipment must be able to withstand stresses imposed both by gusts and in securing. Often the latter are critical in equipment for light packages, operators warned.

For positioning heavy pieces, MATS favored monorails and the Army field forces treadways built to stand 12,000 forces.

Tips on preparing airplanes for transporting cattle came from a Canadian whose company is specializing in the work. They begin by lining the entire interior of the cargo compartment of the airplane. Their regular customers supply canvas linings whose sections join with slide fasteners. Airplanes of other customers are lined with roofing paper. Over the covering on the floor goes a 6-in. layer of wood shavings and then another canvas or paper cover. The cattle are secured to stanchions built out of 2 x 4's and spaced according to the size of the individual animal.

Mindful of the effects of load shifts and overloading, the Canadian cautioned operators to load bulls forward and to instruct amateur herdsmen not to allow cattle to drink their fill at en route exercise stops.

When operators acquire the costly new cargo aircraft incorporating their hearts' desires, commercial operators noted, they will have to improve utilization—a point they haven't worried much about so far because of the low capital value of their present war surplus or converted passenger airplanes. The best way to increase utilization is to speed up ground handling at the terminal, one operator reasoned.

He offered statistics from one airline showing that ground handling takes 85% of the in-transit time on the New York-Detroit run and 67% even on a New York-Los Angeles run. To cut this time, he advocated thorough training and disciplining of

cargo handling personnel and the minimum of paperwork—planned to insure that shipments reach proper destinations rather than to trace them after they are lost. He praised terminal design studies recently made by several aircraft companies.

Result of one of the studies was a V-shaped terminal building described and displayed in model form. Building and dock together cover 44,900 sq ft and can service seven airplanes simultaneously. Cost was estimated at $175,000 for construction and $50,000 for handling equipment.

This design solved the problem of compensating for differences between truck floor and airplane floor levels by providing a truck ramp to a raised truck court, from which cargo can be transferred conveniently to dollies. A conveyor system takes the dollies around to the airplane side of the terminal to loading ramps leading to the airplane door. These special ramps are telescopic and can pivot around horizontal and vertical axes to accommodate the door spacings and levels of various aircraft.

During the morning, participants in the meeting were told that the commercial air cargo industry is moving such commodities as securities, newspapers, women's clothing, seafood, flowers, race horses, and baby chicks. In the afternoon they saw for themselves how it is done now at Newark and some equipment aimed to improve future service.

They observed conveyors loading small packages on a C-47 and climbed into a commercial C-54 and a MATS C-74. They swarmed around a detachable-pod-type "Speedpak" cargo container, remarking at its resemblance to a droppable lifeboat.

Half the group saw a 1950 Ford car raised on the platform of a lift truck and loaded on the new DC-6A Liftmaster, then a DC-4 engine onloaded. The other half watched both items offloaded. All had a chance to go up into the airplane—and almost all who did, thumped its shiny white fiberglass interior walls whose durability had been cited earlier.

At one of the seven cargo terminals visited, they watched a demonstration of a new lift for application to trucks. Mounted on a conventional truck chassis, it rose to a height 13 ft above ground level with its platform always level and without teetering. Vertical speed is adjustable. According to the demonstrator, the hydraulic cylinder of the lifting device proved satisfactory in tests at - 40 F.

All the airport's cargo-flying tenants cooperated on the tour.

CRC Issues Critique On Vapor Lock Tests

AN analytical review of the CRC 1946 vapor lock road tests[1] recently was released by the CFR-MFD Vaporization Characteristics Group of the Coordinating Research Council. Titled "Review of Vapor Lock Road Test, Indio, California, Aug. 26 to Sept. 16, 1946," the report comments on both the vapor lock test technique and analysis of data.

The new report points out a difference in point of view between the CRC Vapor Lock Group, which conducted the tests, and the Vaporization Characteristics Group, which reviewed the work. The former regards the V/L (vapor-to-liquid ratio) notion as a "proposed V/L testing technique." The latter sees it more as a way of thinking about the problem and of handling experimental data to get the most information from it.

Continuing with its interpretation, the review group says the principal effect of the V/L approach on vapor lock testing is to show that more information is obtained when testing two or more fuels (which differ appreciably in their vapor forming characteristics, as defined by curves relating amount of vapor formed to temperature) than is obtained from testing one fuel.

Among other observations made in the report is that the Indio test data shows incipient vapor lock to occur at different speeds on different type fuels. This raises the question as to whether the bottleneck point in the fuel system may change with the volatility of the fuel.

If this speed change does happen, it must be lived with in connection with vapor lock, observes the review group. But it does not find the cause of speed change evident from the available test data and hopes that subsequent testing will clarify this.

A discussion of the Indio data reveals that contamination of samples, analytical testing, or both are such large sources of error as to invalidate any other conclusions. Recommendations made in the report for future work are:

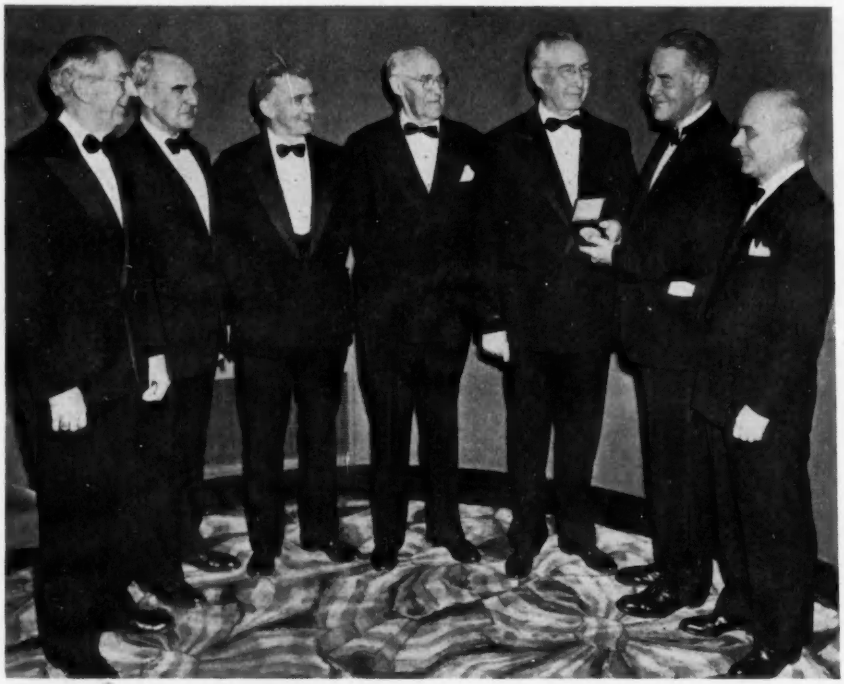
1. To avoid contamination, to detect contamination, and to test the internal consistency of the analytical data.

2. Not to use precalibrated fuels so as to eliminate the contamination question, although checks for internal consistency still will be required.

Leader of the Vaporization Characteristics Group is E. M. Barber, of the Texas Co. The Group is under the Volatility Projects, of the Motor Fuels Division, of which A. J. Blackwood, Standard Oil Development Co., is director.

(The report, CRC-240, has thirty 8½ x 11 pages, including 12 charts. Price: $1.00 to SAE members, $2.00 to nonmembers. It is available from the SAE Special Publications Department, 29 West 39th St., New York 18, N. Y.)

[1] This original test work is reported in CRC-223, "Report on CFR-MFD Vapor Lock Road Tests—Conducted at Indio, California, Aug. 26 to Sept. 16, 1946." This report is available from the SAE Special Publications Department, 29 West 39th Street, New York 18, N. Y. Price: $1.50 to SAE members, $3.00 to nonmembers.



SAE Past-President **EDWARD P. WARNER**, second from right, president of the Council, International Civil Aviation Organization, Montreal, receives the Daniel Guggenheim Medal for his "pioneering research and a continuous record of contribution to the art of science of aeronautics," from **GLENN L. MARTIN**, third from right, chairman of the board of the Glenn L. Martin Co., Baltimore, Md., and chairman of the Daniel Guggenheim Medal Board of Award. Left to right, at the 70th annual meeting of The American Society of Mechanical Engineers in the Hotel Statler, are: Robert B. Lea, chairman of the ASME Air Cargo Program and assistant to the president, Sperry Corp., John H. R. Arms, secretary of the Daniel Guggenheim Medal Board of Award, Preston R. Bassett, past president of the Institute of Aeronautical Sciences, **L. D. GARDNER**, former recipient of the Daniel Guggenheim Medal and one of the founders of the IAS, Martin, Warner, and **LT. GEN. JAMES DOOLITTLE**.

O. W. YOUNG, who started as a lathe and boring operator 42 years ago, has announced his retirement as executive assistant to the general manager of the Buick Motor Division of General Motors Corp., Flint, Mich., the company's highest manufacturing post. He has been appointed Buick dealer in Tucson, Ariz.

EARL W. PUGHE has joined the Wheland Co., Chattanooga, Tenn., as manager of the Manufacturing Division. This division includes the design and production of Wheland oil field drilling equipment and Wheland sawmill machinery. He was formerly assistant to the president of Dana Corp., Toledo. Pughe served as chairman of the SAE Kansas City Section from 1936 to 1938.

WILLIAM B. BIRREN, who recently resigned as director of service and parts of Wright Aeronautical Corp., Woodridge, N. J., has accepted the position of assistant to the president of the Grand Central Airport Co., Glendale, Calif. He was chairman of the SAE Southern California Section for 1937-38.

About

WILLIAM A. CASLER, has been named assistant director of research at Armour Research Foundation of Illinois Institute of Technology, Chicago. He will be in charge of stimulating new fields of research and assist in the administrative operation of the research division. Casler joined the Foundation staff in April 1946 as a research engineer. In September of that year he became supervisor of the propulsion section in the applied mechanics research department, and in March of 1947 assistant chairman of that department. He is currently serving as chairman of the student activities committee of the SAE Chicago Section and is vice-chairman of the Society's student committee.

ROBERT A. LASLEY, formerly chief engineer with the Aircraft and Diesel Equipment Corp., Chicago, is now superintendent of the Research Laboratory, Lima-Hamilton Corp., Hamilton, Ohio.

EDWARD D. HERRICK, formerly president of the Linn Mfg. Corp., Morris, N. Y., has joined American La France Foamite Corp., Elmira, N. Y., as vice-president of engineering and manufacturing.

A. S. D'AMIANO, export service engineer with the Export Division of the Electric Auto-Lite Co., Toledo, has covered most of South America, Africa, the Middle East and Europe in the past year. During these trips, he has checked on manufacturing facilities of battery factories associated with Auto-Lite.

BAYARD D. KUNKLE, a director of General Motors Corp., has recently joined the Nylok Corp., New York City, as vice-president and director. He will act as consultant on all of the corporation's activities. Kunkle was formerly vice-president of General Motors Corp., Detroit.

CHESTER E. MINES, formerly a coordinating engineer in the Aircraft Engine Division of Packard Motor Car Co., Toledo, is now in the Engineering Department of Allison Division, General Motors Corp., Indianapolis, Ind.

Members

DAN M. GUY has been appointed assistant director of technical service in Ethyl Corp.'s research laboratories at Detroit, it was announced by RICHARD K. SCALES, director of technical service. In addition to his new duties, Guy will continue as head of the agricultural section of technical service, a post he has held for four years. Announcement was also made of the transfer of MICHAEL A. ROMONDINO, research engineer in Ethyl's San Bernardino road test laboratory, to the commercial engine and fleet section of technical service operations in the research laboratories in Detroit, and of JOHN D. BAILIE, research engineer in the commercial engine and fleet section, to the agricultural section of technical service.

JOHN C. HUBBARD, formerly an automotive engineer with Kraft Foods Co., Chicago, is now transportation superintendent in the Marketing Division of Cities Service Oil Co., same city.

S. K. HOFFMAN, formerly a professor of aeronautical engineering at The Pennsylvania State College, has joined the Aerophysics Laboratory of North American Aviation, Inc., Downey, Calif. Hoffman was SAE vice-president of the Aircraft Powerplant Activity in 1943.

P. B. MacEWEN is now associated with Ethyl Antiknock, Ltd., Toronto, a subsidiary of Ethyl Corp. In his new position he will handle automotive and fuel problems in cooperation with the various oil refiners and automobile manufacturers in Canada. MacEwen was formerly head of the Research and Technical Standards Section, Directorate of Vehicle Development, Department of National Defence, Ottawa. He was active on the SAE War Engineering Board work on cold starting.

EDWARD L. ASCH has been appointed manager of the recently established Houston, Tex., office of Vickers, Inc., a division of the Sperry Corp., He comes to this territory from the New York area where he worked on both aircraft and industrial machinery applications. Asch has been a member of the organization for nine years.

MARSHALL M. DANA, formerly with the American Locomotive Co., Schenectady, N. Y., is now a special lecturer in the Department of Diesel and Internal Combustion Engines of North Carolina State College, Raleigh. This department is an outgrowth of the specialist school which the Navy established at the college during the war.

J. I. HAMILTON, formerly plant manager with F. V. Lawrence, Inc., Falmouth, Mass., is now general sales manager of the Menasco Mfg. Co., Burbank, Calif. He has been active in the SAE Metropolitan Section, serving as Student, House Committee, and Membership Chairman, vice-chairman of Aeronautics, and secretary of the Section.

ALBERT E. GIBSON has joined Fredric Flader, Inc., No. Tonawanda, N. Y., as a research engineer. He was formerly a chief draftsman in the Aircraft Engine Division of Packard Motor Car Co., Toledo. Gibson was a company representative in the SAE Detroit Section from 1946 to 1948, and has served on several SAE committees.

A. J. POOLE, SR., has been promoted to sales and service manager of Diesel Engine Products by Scintilla Magneto Division of Bendix Aviation Corp., Sidney, N. Y. He began his engineering career in England and came to this country in 1902, and joined Scintilla in 1931. During World War II he was loaned to the U. S. Government to investigate automotive engineering in Germany. He joined the SAE in 1910 and was elected vice-president representing the Diesel Engine Activity in 1932.

CHARLES A. LINDBERGH received the Wright Brothers Memorial Trophy of the National Aeronautic Association Dec. 17 in Washington, D. C., on the 46th anniversary of the late Orville and Wilbur Wright's first flight at Kitty Hawk, N. C. He was cited for "his 22 years of outstanding public service." Today Lindbergh is a special consultant to Gen. Hoyt S. Vandenberg, U. S. Air Force chief of staff. His solo flight across the Atlantic was 22 years ago.

DR. DELTON R. FREY has been named manager of products application with the Deep Rock Oil Corp., Tulsa, Okla. He was formerly head of the fuels and lubricating oil section of the Anderson-Prichard Oil Corp., Oklahoma City. Frey is secretary of the SAE Mid-Continent Section.

JOHN J. HOUSE, formerly service manager of the Canadian Car and Foundry Co., Ltd., Montreal, has joined the ACF-Brill Motors Co., Philadelphia, as a general parts and service manager.

FRED C. HALL has recently been appointed director of sales of the American Coach & Body Co., Cleveland. The company manufactures utility truck bodies. He joined American in 1936 and has represented the company in the western half of the United States.

ROBERT G. LYON has recently been appointed director of product education on passenger cars and trucks with Ross Roy, Inc., Detroit. He joined the company in 1948 after serving as chief engineer with the Visco-Meter Corp., Buffalo, N. Y.

EDWARD D. KEMBLE has recently been appointed plant manager of the automatic heating division, Air Conditioning Department, General Electric Co., Bloomfield, N. J. Prior to this appointment he was plant manager of Clark Equipment Co.'s lift truck plant in Battle Creek, Mich.

DR. P. S. MYERS, associate professor of mechanical engineering at the University of Wisconsin, Madison, was presented the Gold Medal of Award of Pi Tau Sigma at the National ASME meeting in New York City on November 30. He was chosen the "most outstanding mechanical engineer" from the engineering graduates of the period 1939 to 1949 because of "significant achievements and contributions in the field of mechanical engineering." Myers is Placement Chairman of the SAE Milwaukee Section.

T. P. HALL, now president of T. P. Hall Engineering Corp., announces development of a "vicinity" car (The Airway) for about-town transportation. Designed to sell for $500 to $686, the car is 158 in. long, 58 in. wide, weighs 775 lb and is powered by a 10 hp air-cooled engine. The company plans to license other manufacturers to build the car.

GEORGE T. CHRISTOPHER, retiring president of Packard, predicts (in the December "American Magazine") that the car of 1959 is quite likely to be powered by a small and extremely economical gas turbine. "In any event," he says, "the 1959 car will be far ahead of the car you are now driving as this year's models are ahead of the cars of 1934."

LEWIS P. HANKINS is superintendent of equipment of Hemingway Bros. Interstate Trucking Co. which recently received the first annual Truck Shop Excellence Award for for-hire carriers with 100 or more property-carrying vehicles. The Award is sponsored by "Transport Topics" to stimulate better maintenance practices, increase shop efficiency, and give national recognition to companies using adequate machine-tools in well-planned, well-furnished shops..

CHARLES H. ZIMMERMAN, head of the Dynamic Stability Branch of Langley Laboratory, NACA, Hampton, Va., was one of the speakers on Dec. 9 at the first Convertible Aircraft Congress in Philadelphia. His paper was on "Performance and Stability of a Convertible Craft." He designed the XF5U-1 "flying pancake" several years ago, and his paper included NACA wind tunnel tests with a ⅓ scale model of that craft.

C. E. DAVIES, secretary of the American Society of Mechanical Engineers, New York City, was elected assistant secretary of the Engineers' Council for Professional Development for 1949-1950 at its 17th Annual Meeting held at Chicago, Oct. 28-29. The ECPD is a conference body of engineering organizations of the United States and Canada.

RALPH A. BRAIK is northern representative for the West Coast Engine and Equipment Co., Berkeley, Calif. He was formerly sales engineer with the Equipment Supply Co., Inc., El Paso, Tex.

EDWARD F. OBERT, associate professor of mechanical engineering at Northwestern University, is the author of "Elements of Thermodynamics and Heat Transfer." This new book features an orderly and rational development of the science of thermodynamics.

The book has been written to serve as a text for the undergraduate course in thermodynamics and heat transfer.

It stresses real machines, flow processes, properties of fluids, and the conditions where simplified analyses can be applied. The flow of fluids has been emphasized because the problem of fluid flow is one of the more usual tasks that the practicing engineer is called upon to treat.

The book has been published by McGraw-Hill, New York. Its price is **$4.50.**

R. J. F. PORTER is now managing director and owner of Hillsdene Motors, Ltd., Tauranga, New Zealand. He was formerly general service manager of Dominion Motors, Ltd., Wellington, New Zealand.

JOHN L. COLLYER, president of the B. F. Goodrich Co., Akron, was recently decorated with the French Legion of Honor. He received the award for services rendered the Allied cause during the war and for aiding French industry during reconversion.

DUNCAN F. McDONNELL has joined North American Aviation, Inc., Inglewood, Calif., as an engineering draftsman.

L. A. DANSE, supervisor, materials & processes, Production Engineering Section, General Motors Corp., Detroit, was a member of the committee which helped to plan the first course in Air Pollution given by the School of Public Health at the University of Michigan, Ann Arbor. This is the 33rd in a series of non-credit training courses.

SIDNEY E. MILLER, formerly manager of the Engineering Division of American Bosch Corp., Springfield, Mass., has been elevated to the office of vice president in charge of engineering. He has been associated with the corporation since 1944.

FRED HENRY MILHAUPT is now a junior engineer with the Trane Co., Grand Rapids, Mich.

JOHN F. SWIFT is now a transmission engineer in the Advanced Engineering Department, Truck Division, International Harvester Corp., Fort Wayne, Ind. He was formerly supervisor of the Torque Converter Unit, Ford Motor Co., Dearborn, Mich.

C. F. TAYLOR, of the M.I.T. mechanical engineering department, is directing the Sloan Laboratory for Aircraft and Automotive Engines at M.I.T., in exploring the effects of size changes in one-cylinder engines, seeking to establish the "laws of similitude" which may be applicable.

V. L. BOLAND, has joined the Plymouth Division of Chrysler Corp., Detroit, on special assignment to the factory manager.

MARVIN N. BIRKEN, a recent graduate of the University of Southern California, Los Angeles, has joined the Industrial X-Ray Engineers, same city, as an engineer.

FRANCIS J. BOYLE is now a machine designer with the Bryant Chucking Grinder Co., Springfield, Vt. He was formerly a chief engineer with the Mathews Mfg. Co., Worcester, Mass.

ROBERT LEE NELSON has recently joined the Kettleman North Dome Association, Avenal, Calif., as a petroleum engineer.

HARRY LOUIS has just returned after a year in England where he studied service and development methods as a consulting technical assistant for Rolls-Royce, Ltd., Derby. He was previously superintendent of engineering for the Canadian Pacific Air Lines, Ltd., Montreal.

A. B. MARSHALL has been appointed manager of the Detroit office of the Carter Carburetor Corp. He was formerly assistant manager of the Detroit territory. He joined the corporation in 1930 as an engineer, and in 1942 he was loaned to the U. S. Army Ordnance Department as chief of the Engineering Division's Engine Unit.

E. B. MANSFIELD is now a partner of Douglas & Mansfield, Consulting Engineers, Houston, Tex. He was formerly manager of the Truck-Bus and Earthmover Tire Development, Firestone Tire & Rubber Co., Akron, O. Mansfield is a member of the SAE Truck & Bus Activity and Meetings Committees.

OBITUARIES

CARLETON H. BOLIN

Carleton H. Bolin, a Pacific Telephone & Telegraph Co. employee for the past 28 years, passed away on Nov. 18. He was 51.

A native of Oakland, Calif., Bolin was graduated from the University of California in 1922. At the time of his death he was superintendent of motor vehicles for the Pacific Telephone & Telegraph Co.

A member of the Telephone Pioneers of America and past commodore of the Queen City Yacht Club, Bolin assisted in the organization of the SAE Northwest Section.

JULIUS P. HEIL

Julius P. Heil, chairman of the Heil Co., manufacturer of truck and trailer tanks, water systems, oil heaters, and heavy manufacturing equipment, died Nov. 30 on his return from a hunting trip near Milwaukee, his home city. He was 73 years old.

Following a brilliant campaign he upset the LaFollette political machine in Wisconsin and won two terms as governor of the state.

Born in Germany, he was brought to this country when two years old by his parents. He attended rural schools in Wisconsin long enough to learn to read and to memorize the multiplication table, learned blacksmithing and the machinists trade, and became an expert welder.

He was proud of his work as one of the welders' helpers in welding the anchorages on the Manhattan side of the Brooklyn bridge, New York.

Heil founded his own company in 1901 with $500 he had saved. Today the company employs more than 2000. He joined the Society in 1921.

CHARLES HENRY WONDRIES

Charles Henry Wondries, who retired as director of the National Accounts Division, Studebaker Corp., South Bend, Ind., last September, died Dec. 2 in Pasadena, Calif. He had joined his son, Robert, of Bob Wondries Motors, Inc., Alhambra, Studebaker dealership. He was 61.

He attended the University of Chicago and later graduated from Stanford University in mechanical and civil engineering. He was named chief of a survey party of the U. S. Department of Engineering working in the Sacramento River Valley upon graduation in 1909, and was city engineer of Colton, Calif., and a resident engineer for the California Highway Commission.

Wondries served during World War I as a lieutenant in the U. S. Army, and joined White Motor Co. as sales manager for Southern California for six years following the Armistice.

Twenty years ago he joined Studebaker, where he became a leading figure in the automotive transportation business. He joined SAE in 1938.

TECHNICAL COMMITTEE *Progress*

Revamp SAE Standard On Marine Shaft Ends

THE SAE Standard on Marine Propeller Shafts, Hubs, and Couplings has been brought up-to-date with current practice, with two new type coupling flanges added for greater design flexibility.

Among the changes in the shafting and hub portion of the Standard is a revision in the method of measuring the depth of the keyway in the tapered bore of the propeller hub. And in addition to new basic information, the Standard now includes for the first time the surface finish for hubs and shafting.

Propeller shaft couplings with tapered bores, which last appeared in the 1947 SAE Handbook, have been reinstated as a result of users' desires to continue this configuration. These tapered bore couplings are given in the newly revised Standard in size numbers 1, 2, 3, and 4, with the same range of sizes given for propeller shafts.

While a few intermediary sizes have been deleted, formulas are given for determining any intermediary diameters. Name given to this group of couplings is Type I—Taper Bore.

A new series of couplings added to the Standard has the same flange diameters as the tapered bore series; but with a straight bore, and is labelled Type I—Straight Bore. Both these groups—the tapered bore and the straight bore series—are included in a new division identified by type of pilot, which is called the Internal Pilot Type.

A second new group has been added, the External Pilot—Type 2 Straight Bore, because it was found to be current practice in the marine industry. This new type is more compact because of the external pilot; it includes flange diameters ranging from 4.00 to 7.25 in. and is made for shaft diameters ranging from 0.75 to 3.00 in. Flange numbers used offer a key to the diameter. For example, 725 represents a 7.25-in. diameter.

In effect, the coupling changes in the Standard affect only civil craft applications; couplings for Navy and Coast Guard use remain the same.

Members of the SAE Marine Propeller Shaft and Coupling Committee, which developed these revisions, are: G. L. McCain, Chrysler Corp., chairman; D. T. Abbott, Columbian Bronze Corp.; G. W. Beulke, Twin Disc Clutch Co.; N. J. Brazell, U. S. Navy Bureau of Ships; W. F. Burchfield, International Nickel Co., Inc.; Paul Engstrom, Gray Marine Motor Co.; L. S. LeGros, Scripps Motor Co.; D. E. McCready, Michigan Wheel Co.; C. H. Morris, Chrysler Corp.; D. M. Pierpont, Snow-Nabstedt Gear Corp.; P. H. Richardson, Paragon Gear Works, Inc.; and P. G. Tomalin, Naval Engineering Division, U. S. Coast Guard.

26 New, Revised AMS Just Issued

SAE recently released 12 new and 14 revised Aeronautical Material Specifications, developed by the SAE Aeronautical Material Specifications Subdivision.

The new AMS are:

1. AMS 2672—Aluminum Brazing. This specification applies to the joining of aluminum and selected aluminum alloys.

2. AMS 3315—Silicone Rubber Sheet, Glass Fabric Reinforced. Material covered is a sheet consisting of a single ply of woven glass fabric, impregnated and coated on both sides with a silicone rubber compound. It is primarily intended for gasketing or sealing where a thin, resilient, nonporous sheet material is required for operating at temperatures from −65 to +400 F. The material is resistant to deterioration by weathering and engine oil and remains flexible over this temperature range. It is not normally suited for use in contact with fuels due to excessive swelling.

3. AMS 3320—Silicone Rubber Sheet, Glass Fabric (Types 162 and 164) Reinforced, Heat and Weather Resistant (60-80). This covers a sheet consisting of a single ply of woven glass fabric (type 162 or 164) impregnated and bonded between two layers of silicone rubber of essentially equal thickness, molded to an overall thickness of 0.062 to 0.125 in. Application is essentially the same as for AMS 3315.

4. AMS 3602—Plastic Sheet and Plate, Electrical and Heat Resistant (Glass Fabric Reinforced Melamine-Formaldehyde). This material is primarily intended for panels and insulators in electrical systems.

5. AMS 3615—Plastic Tubing (Cotton Fabric Reinforced Phenol-Formaldehyde). Intended for electrical insulation at low voltages and for protection from galvanic corrosion, this material has good machining qualities and good moisture resistance.

6. AMS 3676—Insulation, Sound and Thermal (Resin-bonded Glass Fiber, Medium Filament). The material is furnished as felted pads and is used for insulating aircraft cabins against heat up to 500 F and against sound.

7. AMS 3680—Insulation, Thermal

(Silica Fiber). Furnished as felted pads, the material is mainly intended as a component of the heat insulating blanket for aircraft jet engine tail pipes and tail cones with temperatures up to 2000 F.

8. AMS 4156—Aluminum Alloy Extrusions [0.65 Mg—0.40 Si (63S-T6)]. This material is chiefly for hinges, trim strips, window frames, sills, and moldings—where good surface finish is required. It also can be used advantageously for hollow, partially enclosed, and intricate shapes for which an alloy with good extruding characteristics is needed.

9. AMS 4575—Nickel-Copper Alloy Tubing, Brazed, Corrosion Resistant 67Ni—30Cu), Annealed. Application said to be in fluid lines—such as primer and fuel lines—requiring corrosion resistance with strength relatively high for nonferrous alloys.

10. AMS 5511—Steel, Sheet and Strip—Corrosion and Heat Resistant (18Cr—8Ni), Extra Low Carbon. This steel can be used in parts and assemblies requiring both corrosion and heat resistance up to 800 F, and especially where such parts are welded during fabrication.

11. AMS 5572—Steel Tubing, Seamless, Corrosion and Heat Resistant [25Cr—20Ni (SAE 30310)]. Application is about the same as that for AMS 5511. Also for parts and assemblies requiring oxidation resistance up to about 2000 F, but only when stresses are low at that temperature.

12. AMS 5795—Welding Electrodes, Coated, Alloy, Corrosion and Heat Resistant (Iron Base—20Cr—20Ni—20Co—3Mo—2W—1Cb). This material is used in welding corrosion and heat resistant alloys.

The 14 revised Aeronautical Material Specifications recently released are:

1. AMS 2400H—Cadmium Plating. Largely editorial changes.

2. AMS 3940A—Composition Board. Under "Laminating," discussion has been expanded to include panels 5/16 in. thick. Thickness tolerances in the specification also have been changed.

3. AMS 4083A—Aluminum Alloy Tubing [1.0Mg—0.6Si—0.25Cu—0.25Cr (61S-T6) Hydraulic]. In the section on flattening ability of the tubing, the revised specification differentiates between tubing with wall thickness less than 10% of outside diameter and wall thickness more than 10% of outside diameter.

4. AMS 4135F—Aluminum Alloy Forgings [4.5Cu—0.9Si—0.8Mn—0.5Mg (14S-T6)]. Among the changes here is a slight change in chemistry, with limits for magnesium revised from 0.20 to 0.75 to 0.20 to 0.80. Physical property tables under Hand Forgings has been rearranged and now include test specimens with a cross-sectional area of 16 sq. in.

5. AMS 4139D—Aluminum Alloy Forgings [5.6Zn—2.5Mg—1.6Cu—0.25Cr (74S)]. Revision is chiefly in the physical property tables under Hand Forgings, as in AMS 4135 F.

6. AMS 4210D—Aluminum Alloy Castings, Sand [5Si—1.3Cu—0.5Mg (355-T51)], Stress Relieved. The section on test specimens is now more detailed. Elongation is no longer specified under physical properties.

7. AMS 4805A—Bearings, Sintered, Metal Powder (89Cu—10Sn Oil Impregnated). The requirement on oil porosity has been extended to require that oil will sweat out of the surfaces when the bearing is heated to 300 F. Also chemistry has been changed with respect to copper.

8. AMS 5522A—Steel Sheet and Strip, Corrosion and Heat Resistant (25Cr—20Ni—2Si). Revisions in the chemistry are among the changes in this specification.

9. AMS 5532A—Alloy Sheet, Corrosion and Heat Resistant. (Iron Base—20Cr—20Ni—20Co—3Mo—2W—1Cb). The chemical composition under this specification has been expanded to allow the inclusion of phosphorus and sulfur.

10. AMS 5510D—Steel Sheet and Strip, Corrosion and Heat Resistant [18Cr—10Ni—Ti (SAE 30321)]. This revision does not include colombium in the chemistry, which previously could be substituted for titanium.

11. AMS 5530A—Alloy Sheet, Corrosion and Heat Resistant (Nickel Base—17Mo—16.5Cr—6Fe—5W). Changes here involve a modification in the chemistry, with silicon and phosphorous newly added and composition of molybdenum and chromium revised.

12. AMS 5710A—Steel Valve [20Cr—2.3Si—1.3Ni (0.76-0.86C)]. The specification now includes limits on the check analysis of chemical composition.

13. AMS 7452B—Bolts and Screws, Steel Alloy (Heat Treated—Roll Threaded). Drawings showing flow lines for upset heads have been revised and the length of hardening time for AMS 6320 and AMS 6322 steels has been changed. A slight ovalization of the hole and countersink is permitted in parts having holes for locking devices.

14. AMS 7456A—Studs, Steel, Alloy. (Heat Treated—Roll Threaded). This revision permits a slight ovalization of the hole and countersink in parts with holes for locking devices.

Technishorts . . .

HIGH-STRENGTH BOLTS: A new proposed American Standard on High-Strength High-Temperature Internal Wrenching Bolts has been approved by SAE. SAE and ASME are co-sponsors of ASA Sectional Committee B18, which developed this proposal. When the proposal receives approval of both sponsors, it will be transmitted to the American Standards Association for final approval and identification as an American Standard. This proposal covers bolts intended for high strength work—such as steam turbine applications—where fasteners are subjected to high temperatures in the range of 800 to 900 F for long periods.

THERMOSTAT POCKETS: A project to standardize both flat and pocket flange types of thermostat pockets has been tackled by a subcommittee of the SAE Engine Committee. (The flat flange type is used mostly for overhead valve engines, the cup flange type for L-heads.) Objective of the subcommittee is to develop dimensions to enable the engine designer to design a pocket that will take a standard size thermostat, rather than a special one. Subcommittee Chairman H. B. Drapeau, Dole Valve Co., observed that flow requirements in some engines are now more severe than they used to be. Dimensions should be such that the engine outlet diameter does not restrict water flow through the thermostat.

AAMVA Finds New Uses for SAE Specs

FRESH evidence of SAE Standards' usefulness in motor vehicle administration appears in three specific recommendations made recently by the Committee on Engineering and Inspection of the American Association of Motor Vehicle Administrators. In a report adopted by the parent body, the Committee has recommended:

1. That SAE specs for headlamps for motor scooters, motor-equipped bicycles, and similar vehicles be used as a guide in the approval of such lamps. (These specs appeared in the SAE Handbook for the first time in 1949);

2. That SAE specs for flashing-type turn indicators be used as guides in approval of such indicators for trucks and buses, as well as for passenger cars to which they have been applied in the past;

3. That SAE specs for indicating a school bus is taking on or discharging passengers be preferred in deciding the basis of approval.

The Committee's report in which these SAE references appear grew out of the AAMVA meeting in Oklahoma City last Fall.

Graves '50 Head Of Technical Board

W. H. GRAVES has been named chairman of the SAE Technical Board for 1950. Vice-president and director of engineering of Packard Motor Car Co., Graves has actively participated in development of SAE standards and specifications, particularly those for motor vehicles. He is a past vice-president of SAE and has served on the Technical Board as well as SAE technical committees. Graves succeeds retiring Board Chairman C. E. Frudden.

GRAVES

Vice-president and director of engineering, Packard Motor Car Co.

New Members

SAE President Zeder also appointed six new members to start three-year terms in 1950. The new appointees are: B. B. Bachman, Autocar Co.; R. P. Kroon, Westinghouse Electric Corp.; R. P. Lansing, Bendix Aviation Corp.; R. J. S. Pigott, Gulf Research and Development Co.; L. A. Gilmer, Oliver Corp.; and G. A. Delaney, Pontiac Motor Division, GMC.

Retiring Members

Board members whose terms expired at the end of 1949 are: W. G. Ainsley, Sinclair Refining Co.; J. M. Crawford, General Motors Corp.; W. P. Eddy, Jr., Pratt & Whitney Aircraft; Robert Insley, Continental Motors Corp.; G. A. Page, Jr., Curtiss-Wright Corp.; and V. C. Young, Eaton Mfg. Co.

New Technical Board Members

BACHMAN

Vice-president, charge of engineering, Autocar Co.

KROON

Manager of engineering, Aviation Gas Turbine Division, Westinghouse Electric Corp.

DELANEY

Chief engineer, Pontiac Motor Division, GMC

LANSING

Vice-president, Bendix Aviation Corp.

GILMER

Chief engineer, Oliver Corp.

PIGOTT

Director, engineering division, Gulf Research and Development Co.

Revisions On Roller

BOTH user and manufacturer will find the SAE Standard for Ball and Roller Bearing Lock Nuts and Washers easier to work with because of more complete dimensions given in the newly issued revision. The Standard has been brought into line with current practice and makes interchangeable lock nuts and washers for both roller and ball bearings.

In the revised Standard, to be published in the 1950 SAE Handbook, data on lock nut dimensions for both roller and ball bearings have been combined in one table instead of being given separately. This also is true for the shaft dimensions.

And for the first time the Standard contains lock nuts in all sizes for tapered roller bearings.

Added to the table on shaft dimensions—see Fig. 1—are tolerances on keyway depth L, keyway width N, keyway length M, and thread relief W. Keyway depth L, for sizes AN-132 to AN-140 has been changed from 7/32 to 15/64 in.

The revised Standard also includes changes in tables on the lock nut. Diameter E (see Fig. 2) is now given in terms of maximum and minimum dimensions instead of in fractions. Dimensions for width G and thickness D have been similarly changed.

A new column specifying diameter E has been added to the lock washer table. See Fig. 3. Dimensions for washer bore R have been changed in the revised Standard. Another revision is the change in washer key width S from 0.115 to 0.110 for the first four sizes—W-00, W-01, W-02, and W-03. And key width S for all the washer sizes now is given as a maximum and minimum dimension. Tolerances also have been added for projection V and tang width T. Key bend X too is new to the Standard.

Serving on the SAE Ball and Roller Bearing Committee which developed these revisions are: Chairman D. E. Batesole, Norma-Hoffmann Bearings Corp.; Vice-chairman H. R. Reynolds, Fafnir Bearing Co.; G. W. Carlson, Axle Division, Eaton Mfg. Co.; L. A. Cummings, Marlin-Rockwell Corp.; W. F. Eaton, Bower Roller Bearing Co.; C. F. Gilchrist, Aviation Division, Electric Auto-Lite Co.; A. G. Goergens, Corps of Engineers, Department of the Army; Gunnar Palmgren, SKF Industries, Inc.; H. N. Parsons, Ball & Roller Bearing Division, International Harvester Co.; R. M. Riblet, Timken Roller Bearing Co.; A. H. Schmal, Mack Mfg. Co.; A. R. Spicacci, Bearings Co. of America; S. F. Stewart, Leece-Neville Co.; S. H. Stoner, New Departure Division, General Motors Corp.; and O. W. Young, Hyatt Bearings Division, General Motors Corp.

Modernize Standard Bearing Nut and Washer

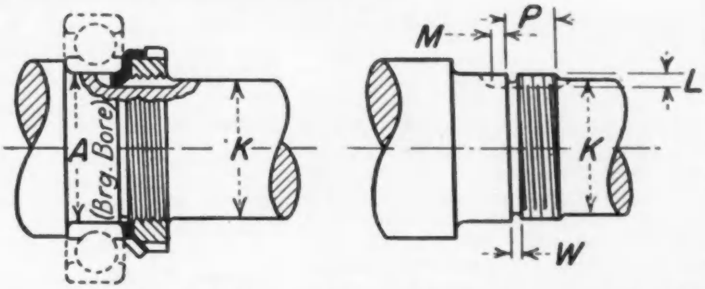


Fig. 1—Shafts for ball bearing lock nuts, shown in the newly revised SAE Standard for Ball and Roller Bearing Lock Nuts and Washers

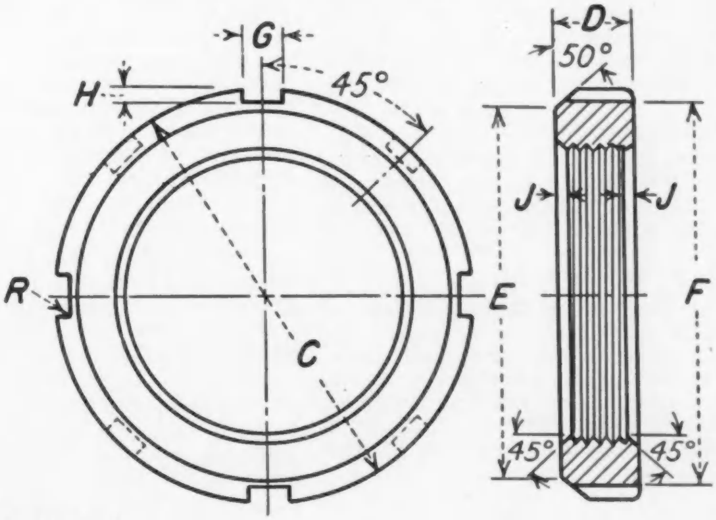
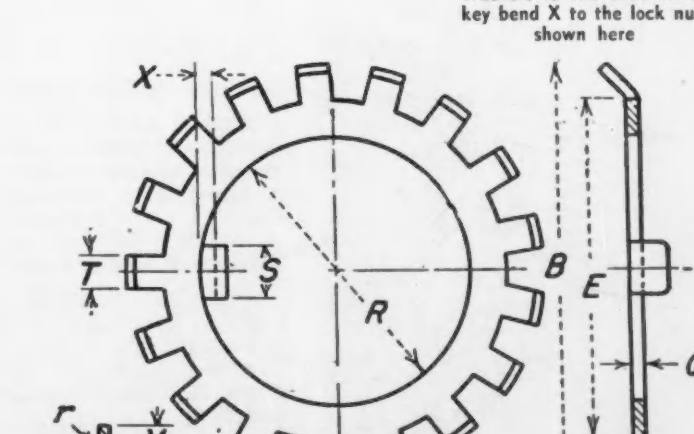


Fig. 2—Configuration of the ball and roller bearing lock nut specified in the revised SAE Standard

Fig. 3—One big change in the revision of the SAE Standard for Ball and Roller Bearing Lock Nuts and Washers is the addition of key bend X to the lock nut, shown here



Shock Strut Group Takes on New Head

C. V. JOHNSON, of Bendix Products Division, Bendix Aviation Corp., has just resigned as chairman of SAE Committee A-12, Aircraft Shock Struts,

C. V. Johnson, Retiring Chairman

R. E. Greenough, New Chairman

because of added responsibilities within his company. R. E. Greenough, of Cleveland Pneumatic Tool Co., succeeds him.

Johnson has headed the Committee since its inception in 1943. He helped create the Committee as well as carry out its useful projects. At the last meeting, Committee members thanked Johnson for his faithful and diligent service during the more than six years that he worked with them.

Greenough has been active in shock strut design for many years and presently is assistant chief engineer of Cleveland Pneumatic Tool Co.

New SAE Group To Rate Winches

A Subcommittee on Winch Rating is being organized under the SAE Transportation & Maintenance Technical Committee. Its objective is to develop an SAE standard for rating winches of the worm gear and spur gear types used in automotive applications, such as public utility trucks. C. H. Hudson, of the Tennessee Valley Authority, heads up the new group.

CALENDAR

Baltimore—Jan. 6

Engineers Club of Baltimore, 6 E. Fayette St.; dinner 7:00 p.m. Customer Relations—T. L. Taylor, director of customer relations, Glenn L. Martin Co.

Buffalo—Jan. 24

Park Lane Restaurant, 33 Gates Circle; dinner 7:00 p.m. Meeting 8:00 p.m. Design of Spring Suspension Systems for Heavy Vehicles—H. R. Swatman, director of tank design, British War Office.

Central Illinois—Jan. 23

Keystone Steel and Wire Co.; meeting 7:30 p.m. Inspection trip through Keystone Steel and Wire Co.

Chicago—Jan. 16

South Bend Division—La Salle Hotel, South Bend, Ind.; dinner 6:45 p.m. Meeting 8:00 p.m. Application and Design of Split Type Bushings—H. W. Luetkemeyer, chief engineer, Cleveland Graphite Bronze Co.

Cleveland—Jan. 16

Thompson Products, Cedar Ave., plant tour 1:30 p.m. (Those attending will assemble at the Thompson Museum, 30th & Chester between 1:00 and 1:15 p.m. Buses will transport members from Museum to plant for the tour, returning to the Museum by the same means between 3:30 and 4:00 p.m. Inspection of the Museum and a Thompson Products sound movie will then be presented.) Cocktail hour at Thompson Museum 5:00 p.m. Buffet dinner at Thompson Museum 6:00 p.m. Presentation of paper at Thompson Museum 7:30 p.m. Subject: Sleeve Bearings, Design and Application. Speaker: Edwin Crankshaw, assistant chief engineer of the Cleveland Graphite Bronze Co. (This meeting will be sponsored by the T & M Activity.)

Dayton—Jan. 10

The Ohio Bell Telephone Co.; dinner 7:00 p.m. Meeting 8:00 p.m. Plant inspection trip. Speaker: Robert C. Clark, public relations assistant.

Kansas City—Jan. 10

Alameda Room, Plaza Cafeteria, on the Country Club Plaza; dinner 7:00 p.m. Meeting 8:00 p.m. Transportation and Maintenance Meeting. Porous Chrome Rings and the Part They Play in Fleet Maintenance—A. J. Weigand, fleet maintenance engineer, Perfect Circle Corp.

Metropolitan—Jan. 19

Statler Hotel; meeting 7:45 p.m. Passenger Car Wind Tunnel Experiments—L. H. Nagler, technical advisor, Nash Motors Division, Nash-Kelvinator Corp., Detroit, Mich. and Kenneth Razak, director of school of engineering, University of Wichita.

Mid Continent—Jan. 20

Tulsa, Okla., Mayo Hotel; dinner 6:30 p.m. T & M Activity. Subject and speaker to be announced.

Milwaukee—Feb. 3

Milwaukee Athletic Club; dinner 6:45 p.m. Survey of Automatic Transmissions Introduced on 1950 Passenger Cars. Slides.

Northern California—Jan. 16

Engineers Club, San Francisco, Calif.; dinner 6:30 p.m. Meeting 7:30 p.m. Service As Applied to Truck Transportation and the Use of Rebuilt Major Components for Economy. Cliff H. Dunn, western division service manager, Motor Truck Division, International Harvester Co. and F. W. Smalley, service manager, Emeryville Works, International Harvester Co. Social hour 5:30 to 6:30 p.m.

Philadelphia—Jan. 11

Engineer's Club, 1317 Spruce Street, Philadelphia, Pa.; dinner 6:30 p.m. Opportunities for Engineering Graduates—Raymond R. Faller, manager of training, Ethyl Corp.

Pittsburgh—Jan. 24

Mellon Institute; dinner at Webster Hall Hotel 6:30 p.m. Service Relationships Between Dealer and Factory—J. H. Mack, general manager, Central Service Division, Chrysler Corp.

St. Louis—Jan. 17

Medart's Restaurant; dinner 7:00 p.m. Development and Application of Modern Automotive Oils and Multiple Purpose Greases—J. W. Lane, manager, Automotive Division, Socony-Vacuum Oil Co., Inc., New York City. Cocktail half hour preceding dinner.

Southern California—Jan. 26

Nikabob Cafe, Los Angeles, Calif.; dinner 6:30 p.m. Plain Facts About Modern Engine Oils—J. A. Edgar, manager, motor laboratory, Shell Oil Co.

Southern New England—Feb. 1

Bond Hotel, Hartford, Conn.; dinner 6:30 p.m. Meeting at Hartford Gas Co. Auditorium 8:00 p.m. Indianapolis Speedway Races—W. Wilbur Shaw, president, Indianapolis Motor Speedway Corp.

Wichita—Jan. 19

Droll's English Grill; dinner 6:30 p.m. The New Look in Lubricating Oils—John H. Baird, Lubrizol Corp.

NATIONAL MEETINGS

MEETING	DATE	HOTEL
ANNUAL MEETING and Engineering Display	Jan. 9-13, 1950	Book-Cadillac, Detroit
PASSENGER CAR, BODY, and PRODUCTION	March 14-16	Book-Cadillac, Detroit
AERONAUTIC and Aircraft Engineering Display	April 17-19	Statler, New York
SUMMER	June 4-9	French Lick Springs, French Lick, Ind.
WEST COAST	August 14-16	Biltmore Los Angeles, Calif.
TRACTOR	Sept. 11-14	Schroeder Milwaukee, Wis.
AERONAUTIC and Aircraft Engineering Display	Sept. 27-30	Biltmore Los Angeles, Calif.
TRANSPORTATION	Oct. 16-18	Statler, New York
DIESEL ENGINE	Nov. 2-3	Knickerbocker Chicago, Ill.
FUELS and LUBRICANTS	Nov. 9-10	Mayo Tulsa, Oklahoma

SAE Section Meetings

Faster Machining Betters Products

• Syracuse Section
L. R. Parkinson, Field Editor

Nov. 21—**Roy T. Hurley** produced an abundance of data to show that many forms of metal cutting can be done best at high speed.

From a detailed study of materials to be machined and equipment to be used, Hurley concluded that making the machine more rugged enables it to operate at higher speed—and high-speed machining is the key to better products.

One of the innovations he described was a lathe so powerful that it could do the work of 13 ordinary lathes, finishing in 9 sec what had required 100 sec on the ordinary lathes.

Hurley is now president of the Curtiss-Wright Corp. and was formerly manager of production engineering for the Ford Motor Co. His topic was "Production Problems in Industry."

Performance Measures Good Engine Design

• Kansas City Section
K. J. Holloway, Field Editor

Nov. 14—Development of a new automobile engine is almost always brought about by need of the industry for some drastic change, stated SAE President **Stanwood W. Sparrow.**

In discussing the development of the engine which has been used in the Studebaker Champion for the past several years, Sparrow pointed out that engineers are interested in performance factors such as acceleration, fuel and oil economy, hill climbing ability, and top speed.

Design features of the automobile, such as frontal area and car weight, must be given consideration in the preliminary stages of design. Another item to be borne in mind is that any engine, to be successful for use in an automobile, must be economically producible.

Although an experimental engine manufactured to nominal dimensions might give excellent results during testing, serious trouble can be avoided by also testing engines which incorporate maximum and minimum clearances prior to placing the engine in production, stated Sparrow.

During the experimental testing of a new engine it is important for the manufacturer to obtain information regarding power developed—both with and without accessories, compression pressures, friction, fuel economy, oil consumption, torsional vibration characteristics, blow-by, heat distribution, and other characteristics of the engine, added Sparrow.

With regard to reliability, while a full throttle endurance run is one of the best checks, it has been determined that cycling tests will bring out certain troubles not evident from endurance testing. However, Sparrow pointed out that the primary concern is what the final engine will do when installed in the automobile for which it is intended.

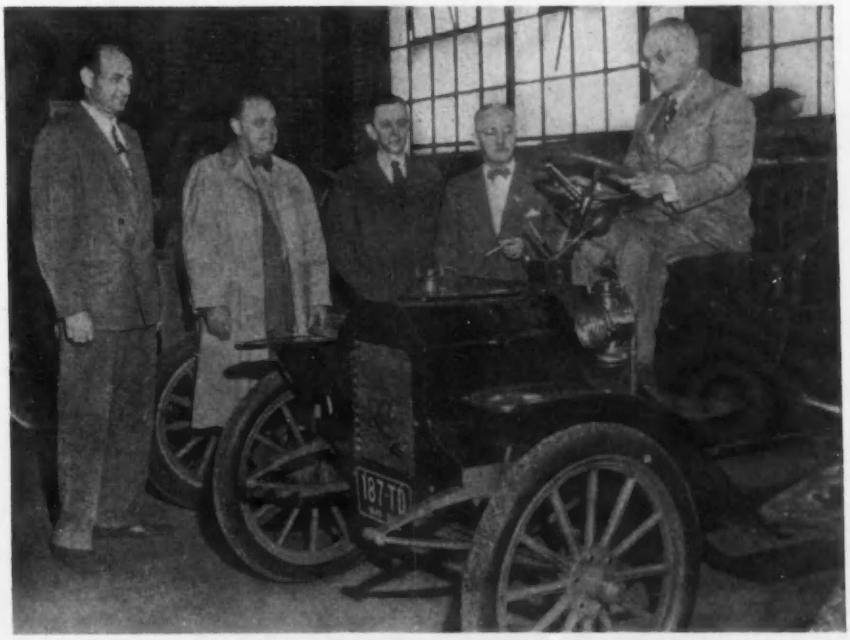
In concluding, Sparrow stated that the only "perfect" engines are those that have been "dead" so long that everyone has forgotten the faults that they did have.

PM Procedures Pay Off in Vehicle Dependability

• Southern California Section
Mel Hall, Acting Field Editor

Nov. 16—"Preventive maintenance procedures do not eliminate the need of a maintenance procedure schedule for the economical operation of a large fleet of motor vehicles." So stated **Francis C. Anderson.**

Anderson, head of maintenance for the power system of the Los Angeles Department of Water and Power, stated that the department had experienced a rise in transportation costs as had other fleet operators. In order to lower the costs on passenger car and truck repairs and operation, a thorough study of modern test instruments and procedures was made. The result of this investigation, and the subsequent conclusions, were the subjects of Anderson's paper entitled, "Modern



Admiring a 1905 Reo in the collection of 16 old automobiles shown to Dayton Section on Nov. 11 are (left to right) E. E. Greiner; J. F. Harrison, who arranged the meeting; Roy Free; V. L. Durrstein; and, at the wheel, C. M. Greiner, owner of the Reo. The exhibit was staged at the Buffalo-Springfield Roller Co., whose road rollers were also on display

Maintenance and Preventive Maintenance Procedures."

Anderson reported that a preventive maintenance and inspection schedule was necessary in order for a fleet operator to capitalize on the potential savings a carefully engineered program would bring about. He felt that with a flexible schedule, such as that used by the Department of Water and Power, savings of ½¢ per mile could be expected.

The department has purchased certain instruments, such as engine dynamometer and chassis dynamometers, to use in the repair and maintenance of their fleet. By scheduling each operation, from daily inspection and maintenance to engine change and overhaul, many expensive road failures are eliminated. The schedule is broken down into various classifications. These breakdowns are dependent upon the type of vehicle serviced, its specifications, and the service duty it performs. By using preventive maintenance, many expensive repairs are done away with.

Anderson concluded that proper dispatching, careful vehicle driving, cooperation with the maintenance shops, lubrication, polishing, and tire and battery service will probably be the most important factors in holding the operating and maintenance cost curve to a minimum. More frequent testing and minor repairing will generally show a short-run rise in the maintenance cost curve, but are imperative when a vehicle fleet is being maintained in such a manner as to be able to meet any emergency that may arise in the operation of a large power system such as is used by the Los Angeles Department of Water and Power.

Quality Control Data Save Money

• Milwaukee Section
H. H. Wakeland, Field Editor

Nov. 4—Effort spent on improvement of quality results in greater quantity of better quality and lower costs, **R. S. Saddoris** told Milwaukee Section members.

Improvement of quality is speeded by quality decisions based on data analyzed by statistical methods, said Saddoris, who is director of quality of the A. O. Smith Corp. Statistical methods enable a judgment of an entire lot of production to be made from a relatively small sample.

Saddoris showed how observations of a few pieces are used to establish the normal frequency distribution curve, which describes the capabilities of the process under study with little risk of error. Using the example of a decision to be based on measurements taken of a single dimension, he demonstrated that one sample gives little information while the second sample gives considerably more information than the first, and each additional sample after the first two yields progressively less information.

The normal frequency distribution curve has definite mathematical characteristics which make it the basis for most quality control work. Histograms and scatter charts are convenient ways of recording sample data for study, Saddoris said.

Discussion of means of coordinating drawing tolerances with the realities of production brought the opinion that in many cases drawing tolerances would be better understood if they were agreed to mean a spread of one sigma (one-sixth of the maximum allowable variation between pieces) on either side of the desired average size.

President Sparrow gets a friendly handshake from Chairman Dean Burleigh, at Wichita Section's Nov. 15 meeting. Dwane Wallace, president of Cessna Aircraft Co. waits to add his greeting

Engine Design Costs Millions, Sparrow Says

• Wichita Section
Don Simon, Field Editor

Nov. 15—Development of a new automobile engine costs millions of dollars and is done by major manufacturers only when other engines cannot be adapted to meet the requirements, SAE President **Stanwood W. Sparrow** told the Wichita Section.

In his talk, "My Friend the Engine," Sparrow outlined the problems involved in designing an engine. Illustrating his discussions with many slides, he traced the development of the Studebaker Champion engine from its conception to the latest production version.

After the engine was laid out to the projected requirements, shop models were built, and as is always the case, he said, many small performance faults had to be overcome by trial and error. When the laboratory performance was satisfactory, the engine then was operated over a great variety of extreme road conditions for extended periods to prove the engine prior to release for production.

The speaker was introduced to the 170 members and guests by Dwane Wallace, president of Cessna Aircraft Co. Hollister Moore, SAE staff member accompanying Sparrow, outlined some of the administrative functions of the Society, emphasizing technical activities sponsored by industry.

4-Man Panel Answers Criticisms of Cars

• Detroit Section
W. F. Sherman, Field Editor

Nov. 14—Various controversial aspects of automobile design were discussed at a symposium, presided over by J. H. Hunt, consulting engineer of General Motors Corp. The panel consisted of Paul C. Ackerman, chief engineer, laboratories, Chrysler Corp.; Howard K. Gandelot, safety engineer, car design, General Motors Corp. and John Oswald, executive engineer, styling and body engineering, Ford Motor Co.

Highlights of the 30-odd questions and criticisms handled by the panel were the following:

Seat adjustment, up and down: Most cars already provide up and down adjustment as the driver's seat slides forward and backward. Independent and costly vertical adjustment is not enough to improve visibility much, unless steering wheel and pedal position could also be altered. This would be very costly.

Steering wheels to "give": Safety type wheels have been in use since 1934 in the very satisfactory form of a somewhat flexible steel wheel covered by plastic or rubberized material. It has flexibility in case of accident yet offers support and protection for the driver. Despite theoretical advantage of proposed hydraulic steering columns, a "sliding" wheel would perhaps give too little support in accidents.

"Big fat cars": They are no bigger or wider than pre-war cars, by actual measurement. Passenger space has moved out to space formerly occupied by fenders and running boards alone. Engine has moved forward, seats are rearranged, to give the public more luggage space. Cars look longer because they are designed to look that way, with lower overall height due to "cradling" passengers. It is true that sales departments are consulted on appearance, that customer research is influential because nobody is better able to report what the public wants. The public takes for granted that engineering features are good in all cars and buys largely on appearance and style features.

Accuracy of Valve Adjustment Cited

• Salt Lake City Group
Dean C. Despain, Field Editor

Nov. 18—Proper valve adjustments and tolerances must be recognized to assure proper results in internal combustion engines, said **Russ G. Riley**, director of merchanidsing for Thompson Products, Inc.

Riley expressed belief that manufacturers will come to the use of Roto Caps in the near future, pointing out that these caps will greatly increase the life of valves. The rotating action of the valve changes the seating position by 6 deg each time the valve is lifted.

Another point discussed by Riley was the proper installation of cylinder sleeves. They should be fitted at room temperature, then chilled in a deep-freeze unit to—20 deg before installation. This method is better than dry ice as the temperature is more uniformly distributed, thus eliminating warping and breaking during installation.

The advantage of copper lined sleeves, which give maximum contract from sleeve to cylinder wall thus increasing cooling, was pointed out by Riley.

Juniors Learn About Spark Plug Making

• Detroit Section
Ruth and John DeWald, Asst. Field Editors

Nov. 28—"A little thing like a spark plug insulator—who would believe that its manufacture could be so complicated!" Such was the comment of Junior members, who visited the Champion Spark Plug Co.'s Ceramic Division in Detroit.

They learned that a spark plug insulator must have good hot dielectric properties, high dielectric strength, good thermal conductivity, good resistance to heat shock, high mechanical strength, resistance to lead compounds, resistance to abrasion and attack by carbon, and low modulus of elasticity.

The first spark plugs were made of porcelain, composed of flint, feldspar, and clay. Flint caused poor resistance to thermal shock, and the feldspar produced poor hot dielectric qualities. Gradually the flint was replaced by sillimanite minerals, while alkaline earths were substituted in part for the feldspar. The clay content was reduced. Improved kilns allowed higher firing temperatures.

When antiknock fuels became commonplace, a new material, aluminum oxide, was introduced, since the tetraethyl lead attacked the silica in the older plugs, forming a low-melting silicate glass. It also tore the surface of the insulator, helping carbon and scale to form.

In Champion laboratories ceramic materials are thoroughly investigated to determine their properties. New compositions are developed to combine high thermal conductivity with high electrical resistance. Juniors saw three-dimensional graphs used to determine maximum values of these properties.

As each new compound is produced, its X-ray pattern and actual composition is determined with an X-ray spectrometer. Sample bodies are subjected to tensile, torsion, and compression tests. Modulus of elasticity is deter-

Stanwood W. Sparrow, left, and Hollister Moore, of the SAE staff, survey large open copper mine in Utah at time of Sparrow's presidential visit to Salt Lake Group

25 Years Ago

Facts and Opinions from SAE Journal of January, 1925

Sessions were held last month at the Department of Commerce in Washington, D. C., on simplification of brake-lining sizes, spark-plug dimensions, and piston-ring sizes. About 40 representatives of motor-vehicle and parts manufacturers and of interested associations, including SAE, were present. . . . No disposition is apparent on the part of the Government to confuse conditions by doing standardization work itself.

■

At an Annual Meeting session devoted to crankshaft vibration studies, there will be shown a rubber crankshaft, molded in the forging die of a six-throw shaft. It will be used by a speaker to illustrate how crankshafts bend in actual use.

■

"Look forward," Neil MacCoull said, "to the day when any good car can be expected to cover at least 100,000 miles with no mechanical attention to the engine."

■

Among interesting features of European design reported by Past-President B. B. Bachman on his return from London and Paris automobile shows were: Use of aluminum pistons appears more general abroad than here. Drop forgings are being used increasingly. But slight attention seems to be paid to heat regulation of the fuel mixture. . . . Right-hand control of cars is in very wide use on the continent, which is surprising because a right-hand rule-of-the-road prevails there.

Those who have a full appreciation of the value of the research work done at the Bureau of Standards will be interested to know that this institution cost the individual taxpayer less than the price of a newspaper for the year 1924. The automotive section cost each taxpayer less than 0.1¢! (Information from talk to Buffalo Section, Dec. 15, by S. W. Sparrow of the automotive powerplant section of the Bureau of Standards.)

■

Government tests have shown that a 5-ton load can be carried as far on one set of six 38 x 9 in. pneumatic tires as on two complete sets of four, according to A. W. S. Herrington at Metropolitan Section Meeting, Dec. 18.

■

"While the ratio of wages paid by German and American automobile manufacturers, respectively, is one to six, the ratio of prices asked for relative products is three to one."—F. E. Junge

■

Seventy-eight applications for individual membership were approved at the SAE Council meeting in New York, Dec. 5. Resignations of 99 members were accepted and names of five members were stricken from the rolls for non-payment default in payment of dues. . . . It was reported that from Jan. 1 to Nov. 30, 1924, 847 applications for membership and Student Enrollment had been received as compared with 697 during the same months of 1923. On Nov. 30, 1924, there were 5428 names on the rolls including affiliate member representatives and enrolled students.

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mined through use of sonic apparatus consisting of an oscilloscope, audio oscillator, and a vibrating specimen.

The manufacturing process starts with the aluminum oxide, alumina, which is sent through a gyratory crusher to break it up into small pieces. The alumina is then passed over a magnetic separator to remove stray pieces of iron.

This latter is important, Juniors were told, since the presence of a good electrical conductor such as iron would prevent good operation of the insulator. Ball mills which grind the material contain balls of the same ceramic composition as the final insulators to prevent contamination of the product.

The alumina next enters the seive, counter current, and hydro-classifiers, where all material of fineness larger than two microns is separated. The fluid from the hydro-classifier contains 60% solid matter, which is then treated with sulfuric acid to remove the last remaining traces of iron.

The material is then partially dried by blowing warm air through a canvas conveyor belt, which sends the mixture to a second group of ball mills.

Additional ingredients of kaolin and feldspar are added to lower the permissible firing range, Juniors learned and the mixture sent to the spray drier where the slip is dried to form small spherical pellets that have the property of flowing, very much like sand in an hour glass.

Now the materials are ready for the hydraulic presses. Rubber molds, with chromium-plated spindles inserted, are filled with the free-flowing pellets and subjected to 5000 psi hydrostatic pressure.

The insulator bodies are formed somewhat oversize and are then ground to size on turning machines using contoured carborundum wheels. The grinding wheels themselves are cut to contour using a 4 to 1 pantograph arrangement and a master pattern.

Next the insulators are loaded into cars for the three-day trip through the tunnel kiln at 2800 F. All ceramic containers and fire brick used in the kilns are manufactured in the Champion plant in order to prevent any possible contamination of the insulators. Segar cones are used to serve as a tentative check on the electrical temperature controls used throughout the firing process, SAE visitors were told.

The glaze is then applied and the bodies are passed through the glazing kiln at 2200 F. Finally the part number and trademark are rolled on and the bodies enter the decorating kiln for firing at 1400 F. After inspection and test the insulators are ready for shipment to the three manufacturing plants in Toledo; Windsor, Ont., and Feltham, England.

Earthmoving Advances Level Unit Road Cost

• Central Illinois Section
I. R. Lamport, Field Editor

Oct. 31—The problems which faced the Division of Highways when it was formed were entirely different from those which it faces now, said **C. M. Hathaway,** chief highway engineer for the State of Illinois.

Highway engineers had very little to guide them in designing for the future when a $60,000,000 highway construction program was approved in 1918. One problem was to construct a pavement that would last over 20 years, and another was to estimate the amount and character of future

traffic. In order to test concrete pavement design, an experimental road was constructed and tested for three years. The highways that were built were adequate for the traffic of the twenties, but no one could foresee the development in both passenger cars and trucks during the next 25 years. By 1936 the number of registered vehicles exceeded the number predicted for 1960, Hathaway related.

The cost of highways has greatly increased due to reduced grades, longer curves, wider pavements, and bridges caused by the change of design in motor vehicles. Unit costs, however, have remained about the same due to rapid advances made in the earth-moving field, he said.

The problems which the Division of Highways face today are those of maintaining and modernizing old highways and constructing new roads with postwar revenues. Maintenance costs of the 14,000 miles of pavement of Illinois have doubled since the war, and the securing of additional right of way has become much more difficult and expensive. Traffic surveys have been of great value in determining the location of new roads and traffic flow aids, according to Hathaway.

There was a lively discussion after Hathaway's talk. The distribution of the gasoline tax was discussed and the need for additional revenue for new roads was pointed out. The heavy wartime truck traffic did much damage to the roads, some claimed, when little material for maintenance was available.

Waviness in sections of some roads is usually due to a poor gravel base, it was explained. In answer to a question about building roads without expansion joints, Hathaway said that each state had a different idea but that Illinois used one expansion and two contraction joints for every 200 ft.

Douglas W. Erskine was technical chairman and the after-dinner speaker was S. Phil Hutchison who spoke on "Prophecies and Appraisals."

Alcohol Injection Adds Octane Numbers

• Pittsburgh Section
Murray Fahnestock, Field Editor

Nov. 21—After witnessing a demonstration of the value of accurately metered amounts of alcohol in the response to pedal mechanisms, one hundred members discussed the effects of metered amounts of alcohol on engine performance.

Speaking without a preprinted paper, but illustrating his short talk with slides, C. H. Van Hartesveldt, vice-president of Thompson-Toledo Vitameter Corp., first showed effects on octane requirements of different engine speeds and loads and effects of such additives as water and alcohol on the octane ratings of the resulting fuel mixtures.

Improvement of engine performance by chemical octanes from gasoline is possible but practical limitations because the refining industry must consider the needs of 50,000,000 motor vehicles, not just a few. Engine performance, he added, can be improved also by mechanical octanes. But both of these trends are for performance at maximum output, so that at part-throttle driving (at which passenger cars are usually driven) there are available plenty of octanes of which no practical continuous use is made.

The function of the Vitameter is to provide additive octanes only when needed—the charts showing that on the average only 1 to 3% of Vitane was used, as compared to gasoline, for average passenger car use. A high-powered car, keeping up with normal traffic, might use only 0.5 to 1% of Vitane. But if cowboy starts are made in efforts to keep ahead of traffic, consumption might go up to 3%.

Referring to economy, the speaker said that during the past 10 or 15 years, there had been practically no increase in tank mileage—all improvements having been devoted to increased performance and zip. He thought the Vitameter might be used to step up the effective fuel by 10 to 13 octanes for increased performance—rather than for fuel economy—although it could be used either way by suitable rear-axle gear ratios.

To increase chemical octanes from 85 to 95 is more difficult, yet more valuable for improving engine performance, than increasing octanes from 65 to 75. So the Vitameter shows its greatest value in providing "additive octanes" when the best gasoline is used, Van Hartesveldt explained.

Concensus at the meeting was that no third grade of fuel (either above or below the regular and premium grades) will be generally available in the immediate future (barring a depression) because of the trouble and expense involved in storing, shipping, and pumping a third grade of fuel. Fleet operators find two grades plenty of trouble, but fleet operators could secure the effect of a higher octane rating of fuel, for vehicles which sometimes need such fuel, by the use of the Vitameter, the speaker said.

Asked whether the Vitameter is now scheduled as factory equipment by any car manufacturer, he replied that sponsors of this device are only courting the "girl," supplying candy and flowers, and that further announcements should be made by the father of the bride.

The speaker pointed out that a high percentage of the equipment now standard on modern cars was adopted by the car manufacturers only after it had received customer acceptance from the car-using public.

Since Vitane contains lead, a ques-

tion was asked as to the effect of this lead on the ignition system. The speaker said there seemed to be less deposit when using Vitane and that any lead deposits from the lead in Vitane were apt to be light and fluffy, easily wiped off, leaving the bare metal. The Vitameter injects additive lead only a small percentage of the time, and since the Vitane is injected only at rich mixtures, there is less excess air left to form oxides of lead. Also, there seems to be less soot from incompletely burned gasoline, Van Hartesveldt reported.

This led to a question on the effect of alcohol on cleaning out the engine, which prompted one Pittsburgher to remark that the amount of alcohol solution used is so small that it was like taking two drops of castor oil—which never did anyone any good.

Present types of Vitameters are now both speed conscious and load conscious, which reduces the amount of fluid necessary, Van Hartesveldt said. The 15% of water is added to the alcohol to raise the boiling point of the Vitane, which is important when the Vitane is stored in a tank under the hood. While alcohol antifreeze might be used as an emergency fluid—when Vitane is unavailable—its use is undesirable because the rust inhibitors in antifreeze solutions might cause wear of moving parts of engine.

Single Purpose Grease Is Goal

• Metropolitan Section
John D. Waugh, Field Editor

Nov. 17—Modern automotive grease developments, testing, and quality control were given a thorough exposition by **G. H. Link,** staff engineer of the Shell Oil Co.

Link described grease as a sponge (the soap) holding a lubricant (mineral oil), which releases the lubricant as required. He also characterized grease as having the properties of a solid at ordinary temperatures, plus ability to flow like a liquid when subjected to shearing forces.

In the early days of the horseless carriage an all-purpose grease, common cup grease, satisfied all chassis requirements, just as common engine oil met all lubricating oil demands. However, as automotive design advanced, special purpose greases had to be developed to meet extreme pressure, high speed, and high temperature operating conditions.

Compounding many greases to meet all of these requirements finally posed a new problem for the user—that of

keeping a heavy maintenance inventory of greases, many different kinds of guns and equipment, and time-consuming service techniques. Now the pendulum has swung back, and the search is well under way for a single, nearly allpurpose grease, Link said.

Modern lubricating technology has aided in this search for a single, best grease. To the list of conventional soaps—aluminum, sodium, and calcium—used in grease, there have been added barium and lithium soaps. These latter soaps are water resistant and possess considerably improved high temperature characteristics, Link said.

The development of multipurpose greases has demanded the most exacting of laboratory and field testing, and rigid quality control, he continued. The Shell laboratories employ cold rooms, humidity chambers, and many specially-designed test rigs. Greases are tested for the temperatures at which they will flow under certain conditions, their penetration ability, and other desired properties. A wide variety of equipment is employed to work grease, whirl it, roll it, and oscillate it under simulated operating conditions.

Field tests are conducted with automobiles, trucks, and busses in regular service. Wheel bearings, torque converters, and other parts using grease are periodically checked for an appraisal of the grease.

Today, the multipurpose greases have proved their worth under all of the laboratory and field test conditions and are being supplied to customers.

Discussion of Link's paper was led by Vincent Riley, automotive superintendent of New Jersey Power & Light Co., who said that his experience with allpurpose grease had been very good. He cited the simplification of servicing, less inventory bother, time saved, and the high performance of the new grease.

U. S. Aid To Iran Has Been Wise

• New England Section
James S. Walker, Asst. Field Editor

Dec. 6—The United States has spent money wisely in assisting the Iranian Government, according to **Major-Gen. Robert W. Grow, U. S. Army.**

A personal friend of the Shah of Iran, Grow stressed these facts:

1. The Shah of Iran is an accomplished, educated, and democratic ruler, a friend of the United States.

2. The Iranian people are industrious, patriotic, loyal, and against communism.

3. The U. S. Military Mission to Iran, as advisers, helped the Iranian Government to set up an army that now guards approximately 1000 miles of border which divides Iran from Russia.

4. The Iranian army, acting through the central government, now has the potential to insure order in their country.

5. Iran's importance lies in its vast oil deposits, its outlet to the sea, and its strategic geographical location.

6. Whatever power controls Iran politically, controls oil, seaports, and a strategic geographical location for war.

7. The U. S. has no commercial interests in Iran, but we receive oil from the British, who control most of the oil holdings in Iran.

8. The Iranian people and government profit from the oil royalties.

9. Russia would like to control Iran, a fact of which the Shah is well aware.

The General implied that Russia could obtain Iran and its oil only by an outright act of aggression.

Pres. Sparrow Speaks At His Own Section

• Chicago Section
R. L. Smirl, Field Editor

Nov. 21—South Bend Division heard one of their own members, **1949 SAE President S. W. Sparrow** talk on his favorite subject, "My Friend, the Engine."

The first thing to determine in planning a new passenger car engine, he said, is the power required. This requires consideration of frontal area (which he described as the area of the hole you put in the garage door if you drive in with the door closed), weight, speed, acceleration, hill-climbing ability, and fuel economy.

Friction is determined by running the complete job and recording the output, then removing or cutting out one unit at a time and recording power, he explained.

Pres. Sparrow Given Huge Birthday Cake

• Mid-Continent Section
H. P. Enders, Field Editor

Nov. 18—Meeting in Oklahoma City, this section greeted SAE President Stanwood W. Sparrow with a huge cake on his birthday. As a chef bore the cake into the dining room where the dinner preceding the meeting was held, the assembled members sang "Happy Birthday."

President Sparrow presented his talk, "My Friend the Engine," then answered questions. Foreign countries tend to use smaller bores and longer strokes than we do, he explained, because the bore figures in the power formulas used for calculating taxes.

Sparrow opined that liquefied petroleum gas might be satisfactory as an automotive fuel if it were available in all parts of the country.

Third Axle Increased Allowable Load by 66%

• Baltimore Section
R. L. Ashley, Field Editor

Nov. 10—As an indication of the improvements in trucks, B. B. Bachman compared his first 12-hr truck ride from Philadelphia to Baltimore with the 2½-hr ride he made to speak at this meeting.

He stated that adoption of the third axle increased the load that a truck could carry 66%. As a consequence of the heavier loads and increased speeds, more positive brakes were developed.

Diesel engines, Bachman continued, are best employed for long runs with large payloads. That is why, he said, we find such engines in use to a greater degree in the West than in the more congested East.

Additives Increased in New Engine Oils

• Spokane-Intermountain Section
R. N. Williams, Field Editor

Nov. 18—New lubricating oils now being introduced contain five times as much additive as older compounded

oils, revealed **George P. Texada** of the Standard Oil Co. of California.

Prime reason for increasing the additive content is to counteract the increased sulfur content of present-day diesel fuels. The higher sulfur content has been causing ring sticking, thereby increasing maintenance needs. Where sulfur was formerly kept down to 0.025%, it now runs as high as 1.25%, Texada said. The more sulfur, the more corrosive sulfuric acid formed, he added.

The SAE classification of crankcase oils, which characterizes viscosity only, was termed obsolete. Reclassifying to show compounding was said to be of increasing necessity.

Oldsmobile Adds Spring Inside Oil Control Ring

• Milwaukee Section
H. H. Wakeland, Field Editor

Dec. 2—Two hundred and fifty members and guests heard the paper "The Development of the Oldsmobile Rocket Engine" presented by Marshall D. McCuen, senior project engineer of Oldsmobile Division, GMC.

McCuen disclosed that changes which have been made on the engine since it went into production include addition of an expander spring behind the oil control ring and elimination of the torsional vibration damper. The vibration damper, he said, was found to be unnecessary, and the expander spring was required to prevent occasional spark plug fouling at low mileages when oil was drawn up past the rings by the high engine vacuums of low car speeds.

With regard to the torque versus speed characteristic of the engine, McCuen stated that 15 different valve timing combinations were tested and the selection made on the basis of the requirements of the Hydramatic transmission. Chromium-plated piston rings were not considered because of their cost, although they reduce cylinder bore wear about 50%, McCuen said. The premium fuel recommended for the 7.25 to 1 compression ratio engine is required for maximum output. McCuen stated that, by retarding the ignition slightly, detonation-free operation could be obtained on regular gasoline, but at some loss in output. An average driver would not notice the loss, McCuen believes.

Twelve past chairmen of Milwaukee Section were present at the dinner meeting and were seated at a place of honor. A certificate of appreciation of loyalty and recognition of accomplishment was presented to Past-Chairman G. D. Sickert by Chairman G. J. Haislmaier in behalf of SAE Council. The announcement that Milwaukee Section is now in first place of the "Middleweight Division" in the competition for new members, made by Membership Chairman C. L. Spexarth, pleased the membership. Spexarth expressed appreciation of the efforts of the special Membership Committee of the section.

Precision Impresses Injector Plant Guests

• Northern California Section
Avon Brown, Field Editor

Nov. 21—"Millionths for sale" might well have been the theme for the diesel meeting, which took the form of an afternoon field trip through the Caterpillar Tractor Co.'s fuel injection equip-

ment plant in San Leandro and an evening session. This plant makes all of Caterpillar's injection equipment.

Guides pointed out a centerless lapping machine which rough finishes pump plungers to 25 millionths of an in. tolerance. Then plungers and barrels are fitted selectively, hand lapped together, and tested in a leak-off fixture. No gaskets are used.

Completed pumps are tested for 24 hr—a green run equal to 72 hr of engine operation.

Speakers at the evening session described Caterpillar's position in the industry. Ed Witt divided earthmoving jobs into three categories: hauls up to 200 ft, which is about the practical limit for bulldozers; hauls of 200 to 1000 ft, where scrapers are best; and longer hauls, which require high-speed carryalls.

Al Agern revealed that underloaded engines give just as much trouble as overloaded engines, although the troubles are different. Warren Brown warned that dust in the crankcase is much more harmful than dust in induction air. Dust in the crankcase, he said, becomes coated with oil and clings to metal surfaces, causing rapid abrasion.

Student News

Ohio State University

Brake assembly and brake testing equipment was the subject of a talk by R. E. Antheil and B. B. Brombaugh of the Inland Mfg. Division, on Nov. 15.

Antheil also spoke on the value and importance of the SAE as an aid to men in industry.

—W. A. Staats, Field Editor

University of Illinois

"No gasoline company is going to let another company come out with a gas that knocks less," stated R. B. Sneed, technical representative of the Ethyl Corp., at the Nov. 16 meeting.

"Octane numbers required for cars differ," Sneed continued. "Some conditions affecting these differences are altitude, humidity, transmissions, temperature, and the drivers themselves."

He pointed out also that a brand of gasoline may vary from area to area, thereby accounting for differences in performance from different tankfuls of gasoline.

—William Gibb, Field Editor

University of Colorado

In the diesel industry today an engineering degree is almost a requisite for employment in sales, production, engineering, purchasing, estimating, and service, according to Robert S. Ogg.

Ogg, educational director of the Diesel Engine Manufacturers Association spoke on Nov. 18.

He outlined a multitude of job opportunities open to engineering graduates in the diesel industries and emphasized the fact that no matter for what industry a mechanical engineer goes to work he will have to deal with diesel power. Therefore it is essential that mechanical engineers have a modern conception of the diesel engine, he said.

The speaker enumerated the failings of the majority of graduate engineers, one of which being the inability of young engineers to write adequate reports. Ogg stressed that report writing is a very important tool in an engineer's livelihood. Reports are the means for expressing his ideas and for

impressing management with his skill.

Another failing is the young engineer's usual reluctance to work at the drawing board for fear he will be stuck at this job indefinitely and so be in a rut. This is an entirely improper attitude, Ogg charged, because much valuable information is to be gained on the board. If the engineer shows ability and personality he will not stay long on the drawing board but will be moved on up the ladder, Ogg said.

—Les Johnson, Field Editor

New Members Qualified

These applicants qualified for admission to the Society between Nov. 10, 1949 and Dec. 10, 1949. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (Aff.) Affiliate; (SM) Service Member; (FM) Foreign Member.

Baltimore Section
Paul Laichinger, Jr. (SM), Stephen Potsko (J).

Buffalo Section
Lawrence A. Zwicker (M).

Canadian Section
J. G. Inglis (M), Robert Russell Yuill (J).

Central Illinois Section
W. C. Cadwell (M).

Chicago Section
Charles Robert Bradlee (J), Lawrence Paul Giannetti (J), Anthony Granatelli (M), Edward L. Hendrickson (A), Joseph D. Kohutik (J), Wyn E. McCoy (M), Richard J. Naras (J), Maurice P. Pauwels (M), George M. Randell (J), Floyd J. Teed (M).

Cleveland Section
Paul LeRoy Hatleberg (J), J. Howard Holan (M), Mahlen Francis Kahler (J), William E. Kilgore (A), W. P. MacKusick (M), Robert P. Shakely (J).

Colorado Group
Charles Monroe Adams (A), Ray McBrian (M).

Detroit Section
William J. Beeler (A), John E. Connolly (M), Forrest Worth Cook (M), Robert C. Cornell (M), Le Roy H. Frailing (M), Frederick J. Graham (A), Leonard J. Granke (A), Saifi T. Haidery (J), Robert T. Keller (M), Paul C. Kennedy (J), Anton Krapek (J), Henry Lemak (M), Walter Bertrand Mills (J), Edward F. Pinardi (A), H. B. Reich (M), Russell M. Richardson (A), Newton Skillman, Jr. (J), Spencer D. Sleight (J), Daniel Richard Veazey (J).

Hawaii Section
Thomas S. Putnam (A).

Indiana Section
Arthur E. Brown (J), Thomas G. Driscoll (J), Robert Elmer Johnston (J), Storey M. Larkin (A), Robert M. Swearingen (J).

Metropolitan Section
Bruno Butti (J), Albrecht Goertz (A), Arthur Kaplan (M), Albert Saliano (J), Irwin Schiff (J), Arthur Stutzer, Jr. (J), George J. Wile (J).

Mid-Continent Section
James N. Barker (J), Albert N. Janco (J).

Milwaukee Section
Origen S. Perkins (M), Leonard R. Risse (J), William G. Searles (J), Louis James Svoren (J).

New England Section
Herbert England Jacques (J).

Northern California Section
Henry F. Kleemeyer (A), Wilfred J. Lamorey, Jr. (J), Leonard Peabody Richardson (J), Fitzhugh Smith Rollins (M), W. W. Schuldt (A), Sidney D. Selan (J), Samuel Weiss (A).

Northwest Section
Howard H. Arnold (J), John B. Hanson (A), Glenn A. Henry (A).

Philadelphia Section
Theodore R. Gensel (J), Howard Andrew Roberson. (J)

Pittsburgh Section
Don. W. Gow (M), Edward P. White (M).

St. Louis Section
John Richard Mylin (J).

Southern California Section
Lee Stanley Akin (J), Roland E. Gagon (J), Robert Hugh Hornidge, Jr. (J), Sam M. Kelly (A), Herbert L. Podell (J), Robert Leland Vandeveer (J).

Southern New England Section
William Crampton Becker (J), Louis M. Fiteny (J).

Syracuse Section
Robert White Curran (J).

Texas Section
Vincent Paul Citrullo (A).

Virginia Section
Michael W. West (A).

Western Michigan Section
John M. O'Brien (J).

Williamsport Group
Carl G. Seashore (M).

Outside of Section Territory
Francis Hugh Hymers (A), Karl Siegle (J), Leo W. Worten (A).

Foreign
Sydney William Gordon Edlin (FM), Singapore; Joseph Ehrlich (FM), England; Jack Lyndhurst Hepworth (FM), England.

Applications Received

The applications for membership received between Nov. 10, 1949, and Dec. 10, 1949 are listed below.

Atlanta Group
James Edward Coleman.

British Columbia Section
Stanley A. Reeves, John Walter Wake.

Buffalo Section
Paul E. Mohn.

Canadian Section
William M. E. Clarkson, John Scott

Murray, Howard S. Rees, Stephen M. Young.

Central Illinois Section
Richard Eugene Berger.

Chicago Section
R. E. Bradley, Phiroze Eruchshaw Chinimini, James K. Gaylord, T. D. Hayes, Arthur T. Porter, Charles Richard Racine, Thur L. Schmidt, Frank Owen Tallman.

Cleveland Section
Locke P. Atwell, Roger Owen Bay, Walter W. Bulgrin, William N. Di Palma, Raymond W. Heintz, Donald L. Lorenz, Lovell Shockey.

Colorado Group
Rollin Ford Allyne, A. L. Springer.

Detroit Section
Herbert W. Becker, John T. Benedict, Richard Lindabury Berry, Henry C. Bogle, Harry Bowering, Robert Lytle Collins, William A. Compton, Ralph L. Darch, Dorman B. Dickerson, Jr., C. J. Edwards, Jr., C. Gail Ferguson, John E. Hilton, Clevoe D. Jones, James G. Kennedy, Charles C. Kostan, Waldemar R. Kotoucek, Douglas T. Lewis, Floyd Wilfred Little, Vincent Edward Masko, Henry C. McQueen, Richard L. Merrell, Joseph Albert Oeming, Arthur Pachulski, James M. Porter, Wilbur F. Schreiber, Frederick A. Scotton, Arthur H. Stahlhuth, Jesse D. Sewell, J. Bernard Siegfried, Leslie G. Taylor, Lonnie J. Thomas, C. James Warner, John E. Weilemann.

Indiana Section
Raymond H. Cowles, Robert Charles Schmidt.

Metropolitan Section
Paul B. Alper, Edward Baruch, Charles Henry Brock, II, Tench Francis, Norman Gerald Froomkin, Kurt Goldmann, John G. Lippert, Saul Perlin, Quentin G. Pletsch, Morris Kenny Withee.

Mid-Continent Section
Bert C. Frichot, Jr.

Milwaukee Section
Edward H. Belot, Floyd Alfred Blake, Richard M. Cors, Henry Andruss Martin, Jr., William J. Pankratz, Steen Strand.

Mohawk-Hudson Group
Perle E. Kezer, G. Robert McRobbie.

New England Section
Sherman Guy Forbes, Jr.

Northern California Section
William Paul Bardet, Sumner H. McAllister, Fred W. Van Amburgh.

Northwest Section
J. Norris Pearson, Jr.

Oregon Section
Elmer D. Sowers, Preston Murray, Charles A. Richmond, Edward Benjamin Wagner.

Philadelphia Section
Ralph S. Anderson, George A. Marshman, Murray K. Simkins.

Pittsburgh Section
Henry J. Grance, Jr., H. P. Hobart, Thomas J. Hutchison, Jr.

Salt Lake Group
Hal P. Babbel, DeVon Crosby.

Southern California Section
Frank C. Butch, Henry D. Pugh.

Southern New England Section
Pieter W. Schipper, Irving Twomey.

Spokane-Intermountain Section
William O. Alexander.

Syracuse Section
John E. Dahl.

Texas Section
John Burns, Wesley I. Lane, Jr., James O. Quinn, Edwin L. Stoorza, Sr., William B. Tilden.

Twin City Section
S. H. Knight.

Washington Section
George Walter Dorr, Philip L. Ward.

Williamsport Group
Carmine Pinto, Allen Weiss.

Outside of Section Territory
Richard G. Abowd, Jr., Kenneth H. Basilius, Leslie Roy Betteridge, I. B. Granger, Roy E. Knoedler, William P. Oehler, Howard J. Opper, Edward C. Wood.

Foreign
Albert Coppens, Belgium; Orazio Satta Puliga, Italy; Thomas Drayton Walshaw, England.

HAVE YOU Changed Your Address?

So that your SAE mail will reach you with the least possible delay, please keep SAE Headquarters and the Secretary of your local Section or Group advised of any changes in your address. Such notices should be sent to:

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2. The Secretary or Assistant Secretary of your Section or Group at the addresses listed below:

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Floyd E. Ertsman, Chicago Section, SAE, 1420 Fisher Bldg., 343 S. Dearborn St., Chicago 4.

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Delton R. Frey, 234 N. Highway, Route 2, Cushing, Okla.

Milwaukee

Charles H. Duquemin, Le Roi Co., 1706 S. 68th St., Milwaukee 14, Wis.

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Edward G. Moody, Ed. G. Moody, Inc., 680 Columbus Ave., Boston 20, Mass.

Northern California

Morris H. Pomeroy, P. O. Box 427, Burlingame, Calif.

Northwest

Alfred P. Nelsen, Wagner Electric Corp., 1918 First Ave., S. Seattle 4,

Oregon

Edward A. Haas, 6334 N. Missouri Ave., Portland 11, Oreg.

Philadelphia

Linn Edsall, 2301 Market St., Philadelphia 3, Pa.

Pittsburgh

Warren J. Iliff, Equitable Auto Co., 214 N. Lexington Ave., Pittsburgh 8, Pa.

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Thomas Reeves, Continental Motors Corp., Muskegon, Mich.

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Kenneth G. Custer, 1216 South Williams, Denver 10, Colo.

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A. Frank Geiler, Schenectady Railway Co., 121 Erie Blvd., Schenectady, N. Y.

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